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MX: MILESTONE II. FINAL ENVIRONMENTAL IMPACT STATEMENT. VOLUME --ETC(U)

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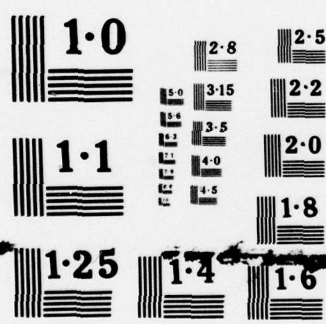
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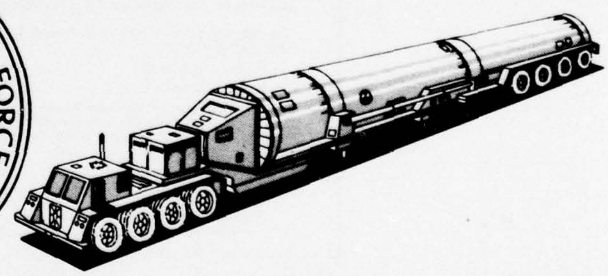
Full-Scale Engineering Development



Environmental Impact Analysis Process

FINAL
ENVIRONMENTAL IMPACT STATEMENT

MX: MILESTONE II

DEPARTMENT OF THE AIR FORCE

FINAL ENVIRONMENTAL IMPACT STATEMENT
MX MILESTONE II

VOLUME I: PROGRAM OVERVIEW

VOLUME I PRESENTS AN OVERVIEW OF THE ENTIRE MX SYSTEM INCLUDING:

- THE MX MISSILE AND BASING MODE ACQUISITION PROCESS
- THE ENVIRONMENTAL PROGRAM AND ENVIRONMENTAL STATEMENTS TO BE PREPARED FOR DECISION-MAKERS AND THE PUBLIC
- A SUMMARY OF THE POTENTIAL ENVIRONMENTAL EFFECTS OF PAST AND FUTURE MX DECISIONS
- IDENTIFICATION OF FUTURE ACTIONS ANTICIPATED AS PART OF THE MX SYSTEM

VOLUME II: FULL-SCALE ENGINEERING DEVELOPMENT

VOLUME II ADDRESSES THE ENVIRONMENTAL IMPACTS OF EXPENDITURE OF RESOURCES TO DESIGN, CONSTRUCT, AND TEST MISSILE AND BASING MODE VEHICLE COMPONENTS AND THE ASSEMBLED MISSILE AND VEHICLES. KEY ISSUES ARE:

- EXPENDITURE OF $5 TO $7 BILLION FOR FULL-SCALE ENGINEERING DEVELOPMENT (FSED)
- CREATION OF JOBS THROUGHOUT THE NATION
- GROWTH INDUCEMENT CONCENTRATED IN 9 STATES
- CONSUMPTION OF ENERGY AND WATER RESOURCES
- ATMOSPHERIC EMISSIONS

VOLUME III: MISSILE FLIGHT TESTING

VOLUME III PROJECTS ENVIRONMENTAL IMPACTS OF MX FLIGHT TESTS ON VANDENBERG AIR FORCE BASE AND CENTRAL CALIFORNIA. KEY ISSUES INCLUDE:

- GROWTH RELATED IMPACTS TO NORTHERN SANTA BARBARA COUNTY
- CUMULATIVE IMPACTS OF MX, THE SPACE SHUTTLE, AND THE PROPOSED LNG PLANT
- FOUR CANDIDATE SITING AREAS (CSA) WERE EVALUATED TO ASSESS SITE SPECIFIC ENVIRONMENTAL IMPACTS RELATED TO THE FOLLOWING KEY ISSUES:
  - –TRANSPORTATION
  - –WATER RESOURCES
  - –RARE OR ENDANGERED SPECIES
  - –AIR QUALITY
  - –ARCHAEOLOGY
  - –MINERAL RESOURCES

VOLUME IV: *BASING* MODE EVALUATION

VOLUME IV EVALUATES THE ENVIRONMENTAL IMPACTS ASSOCIATED WITH THE FOLLOWING FOUR BASING MODES:

- VERTICAL SHELTER
- BURIED TRENCH
- HORIZONTAL SHELTER
- SLOPE-SIDED POOL

THE POTENTIAL FOR ENVIRONMENTAL IMPACT ASSOCIATED WITH EACH BASING MODE IS EVALUATED AT SEVEN BASING MODE COMPARISON AREAS (BMCA) THROUGHOUT THE WESTERN UNITED STATES. KEY ENVIRONMENTAL ISSUES INCLUDE:

- VARIATION OF SPACING BETWEEN AIMPOINTS
- AREA SECURITY VERSUS POINT SECURITY
- DISTURBED OR UNDISTURBED ENVIRONMENT
- PUBLIC OR PRIVATE LAND
- WATER RESOURCES REQUIRED
- CONSTRUCTION RESOURCES REQUIRED
- ENERGY RESOURCES REQUIRED

VOLUME V: APPENDICES

VOLUME V CONTAINS:

- BIOLOGICAL APPENDICES AND SPECIES LISTS
- REGIONAL INDUSTRIAL MULTIPLIER SYSTEM (RIMS) DESCRIPTION
- BASING MODE EVALUATION
- GLOSSARY
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VOLUME VI: PUBLIC COMMENTS

VOLUME VI PRESENTS PUBLIC RESPONSE TO THE DRAFT ENVIRONMENTAL IMPACT STATEMENT. INCLUDED IN THIS VOLUME ARE:

- LETTERS RECEIVED FROM AGENCIES AND ORGANIZATIONS
- RESPONSES TO QUESTIONS RAISED BY THE PUBLIC
- PUBLIC HEARING TRANSCRIPTS

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FULL-SCALE ENGINEERING DEVELOPMENT SUMMARY

Full-scale engineering development (FSED) of the MX missile is basically a refinement of existing intercontinental ballistic missile technology. Refinement of the technology is not expected to cause new or otherwise significant environmental effects. Therefore, FSED is not expected to cause any significant impacts upon the environment other than the expected effects on capital and labor resulting from any multi-million dollar project.

The ICBM Program Office at Norton Air Force Base, California will manage the MX Program. The Program Office will let contracts for the design, fabrication, and test of individual elements of the MX system; these system elements will be developed in facilities throughout the United States. Environmental consequences of full-scale engineering development are examined at three levels: national, regional, and site specific. Site specific effects are primarily a function of testing and validation activities while national and regional effects are primarily a function of the investment of several billion dollars for development and manufacturing.

SITE TEST IMPACTS

FSED will include testing activities to be conducted at increasing levels of complexity as full-scale engineering development moves from design and development of individual components and assemblies, to production and integration of complete subsystems including the missile itself. Test objectives encompass subsystem compatibility, performance and reliability. Among these are wind-tunnel tests, simulated nuclear effects and destruct tests of main-motor stages. Three government test facilities have been identified:

- Arnold Engineering Development Center, Arnold Air Force Station, Tennessee

- Air Force Rocket Propulsion Laboratory, Edwards Air Force Base, California
- Kirtland Air Force Base, New Mexico

Test programs at these specific sites will represent a continuation of similar activities and are not expected to produce impacts unique to MX full-scale development.

NATIONAL IMPACTS

At the national level, the expenditure of money for MX and the resulting competition for natural resources, will occur over a five-year period. This FEIS evaluates impacts resulting from FSED expenditures of $5.0 to $7.0 billion. The range of potential costs will narrow as several key decisions including choice of the basing mode security system, and spacing of aimpoints are made.

Development of MX will create a demand for some unemployed or alternatively employed aerospace workers to reenter the industry, as well as additional competition among aerospace companies for currently employed workers. In addition, economic stimulation will create additional jobs nation-wide in indirect and induced industries. The number of jobs resulting from full-scale engineering development is dependent upon the level of unemployment in the nation at the figure of full-scale engineering development expenditures and the source of full-scale engineering development funds. Funding through taxation and 4 percent of the work force unemployed would result in approximately 20,000 direct and indirect jobs nationally. An 8 percent unemployment level with the same expenditure would result in approximately 130,000 direct and indirect jobs.

REGIONAL IMPACTS

The $5 to $7 billion MX expenditures analyzed in this report will induce employment adjustments in those regions with industrial specialization in aerospace. In turn, population and demand for housing and requisite services will be affected. Aerospace industry employment is concentrated in about 20 states while many other states will be involved in development of the guidance system, transportation system, and propulsion systems. The MX expenditures related to development of prototype missiles and missile transporters is expected to be concentrated in the following nine states:

- California
- Washington
- Colorado
- Utah
- Massachusetts
- Texas
- New York/New Jersey/Connecticut

Specific regional impacts are:

- Increases in job opportunities, both directly working on the MX project, and indirectly as a result of economic stimulation. Total jobs in any one region created directly and indirectly from full-scale engineering development could range as high as approximately 47,000 in the State of California. Exact numbers will depend on award of contracts.

- Potential local population growth resulting from increased employment. Since employment in aerospace and support industries is heavily concentrated in large metropolitan areas, population in-migration is expected to be small except at a very localized level.

- Water and energy resources. Current water supply constraints may inhibit growth in specific states including parts of southern California. Electric power supply may be impacted in certain regions in the northeastern United States.

- Air quality. Except for propulsion systems testing, most developmental activities themselves do not directly produce atmospheric pollutants. Propulsion systems will be developed at facilities which already possess the required technological capabilities, and have conducted similar tests over the years. Indirectly, air quality degradation resulting from increased population, transportation, and energy consumption is expected to be minimal; effects would be observed only at a very localized level.

There are three project alternatives to full-scale engineering development:

- No project
- Development and modification of existing systems
- Alternative development schedules, including delay or postponement
- Adopting an alternative missile to MX or MM III

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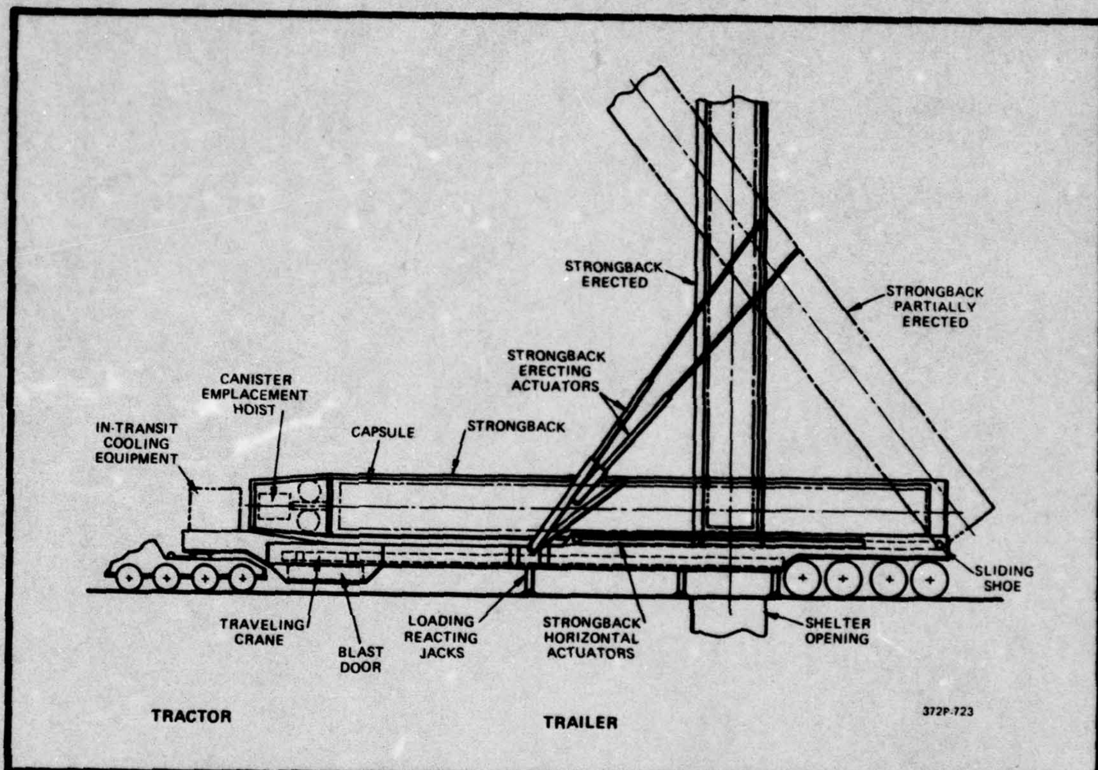

Introduction

INTRODUCTION

The overall objective of the full-scale engineering development program is to evolve a weapons system that will meet all defined mission needs at an acceptable cost, and to perform sufficient testing so that the system can proceed into full-scale production and deployment with minimum risks, meeting the target date for its initial operational capability. Design and development of support items, such as training equipment and facilities, will also begin in order that the operational schedule can be met. Figure I-1 shows the sequence of the MX system acquisition process, which is described in Volume I. Milestone II of the acquisition process is the decision whether to proceed with full-scale engineering development of the MX system.

The ICBM Program Office at Norton Air Force Base, California, will manage the program. The Program Office will let contracts for the design, fabrication, and test of individual elements of the system; these will be developed in contractor facilities throughout the United States.

An "Associate Contractor" structure rather than a single prime contract award is planned. In this approach, separate contracts are let directly by the Air Force for major system elements, rather than having these efforts subcontracted by a single prime contractor. An Assembly, Test, and System Support (AT&SS) contractor will assure the mutual compatibility of the elements comprising a major subsystem (e.g., the missile proper), integrate the subsystem, and participate in its tests. The Program Office is responsible for integration of the complete weapons system.

<u>Full-Scale Engineering Development of Systems</u>

<u>Missile System</u>. The overall features of the Missile X are described in Volume I. It is to provide greater throw weight and accuracy than Minuteman, have sufficient strength to withstand movement, be

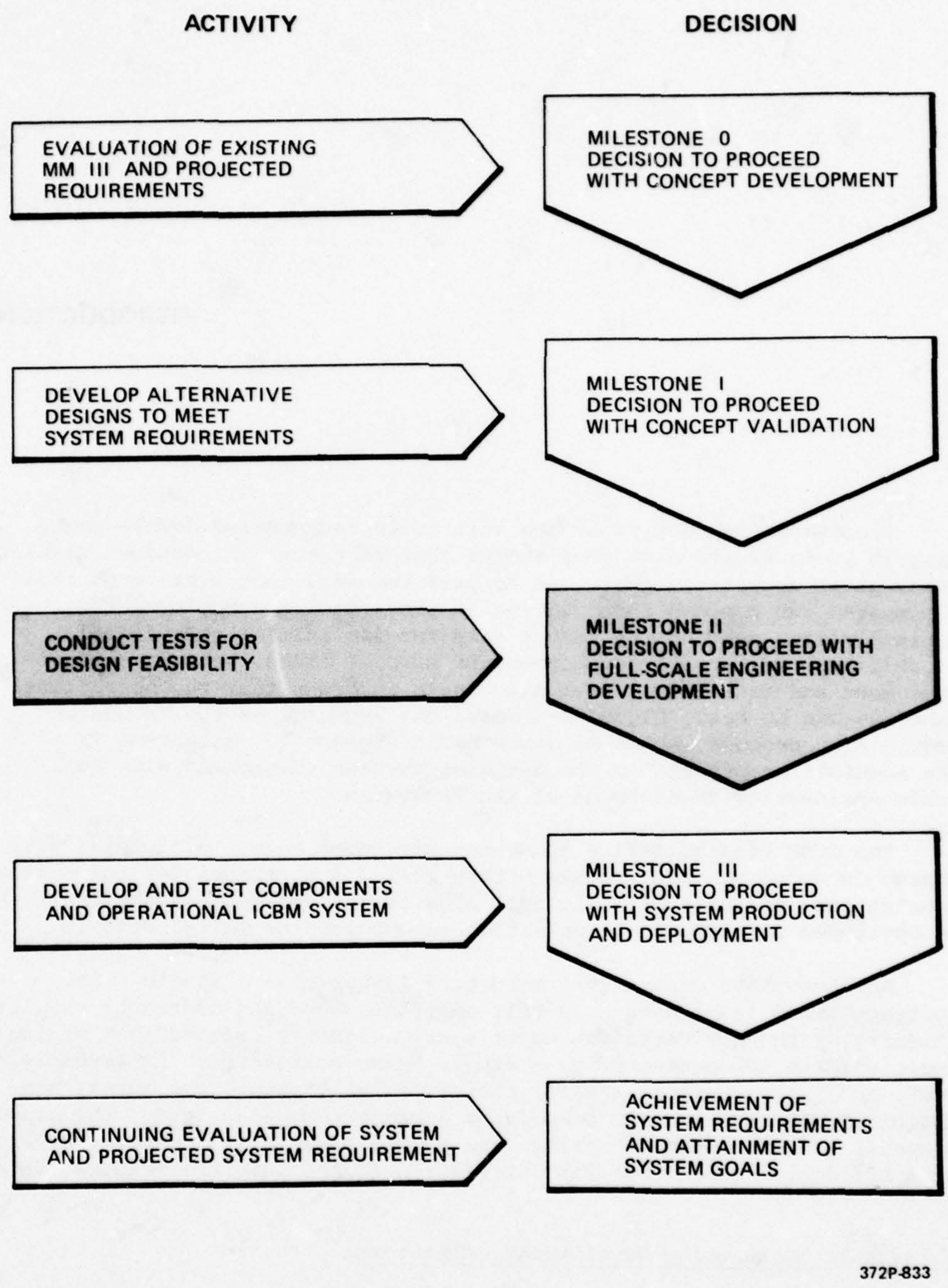

Figure I-1. Milestone II phase of the MX system acquisition process.

capable of erection from the horizontal to the desired firing angle while retaining guidance system accuracy, and be suitable for launching at non-vertical angles.

The entire missile will be encased in a steel canister that will serve as a protective shield during transportation and provide an element of security to the missile and its reentry vehicles. The canister also provides electromagnetic pulse (EMP) protection to the missile. Its prime purpose, however, is to provide a launch capability in which a gas ejection system pops the missile from the canister and imparts an initial velocity before the main engine (Stage I) is ignited.

As currently envisioned, the missile consists of three solid-propellant boost stages (Stages I through III), and a post-boost vehicle containing:

- a post-boost propulsion system (Stage IV) with a liquid bipropellant fuel
- A guidance and control system, with remote retargeting capability
- a reentry system which can accurately deliver multiple independently targeted reentry vehicles to designated strategic targets

An instrumentation and flight safety system is also required to provide data for test flights and to permit flight termination if required for safety purposes. This system is not part of operational missiles.

Contracts have been awarded for continued validation of all four propulsion stages. Predevelopment integration and system definition studies are to be conducted under these contracts. A contract has also been awarded for Assembly, Test, and System Support, in which systems engineering studies will be conducted and interface requirements developed for the missile. These contracts include options which may be exercised by the Air Force for continuation of the efforts through full-scale development. These options have not been exercised to date and will not be for some time, if ever. Other contractors may be expected to express a strong interest in winning future contracts.

Additional contracts have been or will be let subsequent to the Milestone II decisions for design, development and test of the:

- reentry systems
- guidance and control system (including contracts for the computer, advanced inertial reference sphere, specific force integrating receiver, and third generation gyro)
- instrumentation and flight safety systems (including contracts for the aerospace vehicle equipment and ground support equipment)

Ground Systems. Details of the ground systems to be developed in the full-scale engineering development phase will be determined in part by the specific basing mode selected at Milestone II. The elements of the ground systems to be developed include:

- the selected aimpoint configuration
- special ground vehicles
- roads
- supporting facilities
- command, control and communications (C^3) elements unique to the system
- physical security systems
- concealment/decoy systems
- ground power systems
- logistic support systems
- training systems

The overall functions to be provided by the ground systems were outlined in Volume I of this Environmental Impact Statement.

Full-scale testing of hardness and survivability factors for the selected mode will be required in the FSED phase, since most existing data are at reduced scale.

Cost and performance risks associated with the shelter vehicle were reduced during the validation phase by using standard commercial equipment to achieve least-cost approaches. Two competitive conceptual trench vehicle designs were also evolved to provide confidence in the feasibility and minimize technical and cost risk. Breakout tests are also being conducted to verify breakout and erection from the buried trench.

Design and construction techniques for roads and support facilities are well established.

A communication study, model level tests on advanced code storage devices, and development and test of a mobile antenna formed part of the validation phase for the C^3 system required for MX.

A wide area surveillance radar (WASR) compatible with the area security concept has been developed and was tested in the validation phase.

Advanced power sources (special batteries) for post-attack survival power have also been studied in sufficient depth to minimize FSED risk. Peace-time (including emergency) power systems can be designed with confidence and minimum cost risk, predominantly using existing commercial components.

Defined ground system contracted efforts during full-scale engineering development will include design, development, and fabrication and/or limited production or construction of the:

- ground vehicles
- command, control, and communications system
- power systems
- physical security system
- roads and utilities

The protective structures and support facilities will also be designed during FSED. Test facilities will also be designed and constructed as required.

Production of Missile Prototypes

Complete prototype missiles will be required for both ground tests and the planned series of 20 flight tests. Missiles will not, however, be "produced" as complete units at a single facility, but will be assembled in the field by interconnecting the four stages while they are being installed into the canister which forms an integral part of the launch system. Assembly, integration, and preflight testing of both ground and flight test missiles at the Vandenberg AFB (VAFB) flight test facility will be a responsibility of the AT&SS contractor.

Full-Scale Testing

Flight Testing. Flight testing at Vandenberg AFB will include two cold-launch missile ejection tests, and approximately 20 launches into the Western Test Range and is covered in Volume III.

Component Test Program. The primary objective of the MX Development Test Program is the development and interim operational test and evaluation of the MX and canister systems. This process includes tests and analysis necessary to support subsystem development and initial flight tests. The specific tests which comprise the MX Development Test Program are listed in Table I-1. Most of these tests are to be conducted at Vandenberg AFB and are the subject of Volume III of this report.

Tests to be conducted at government test facilities are described below. Three test facilities have been identified to date. These are:

Table I-1. MX development tests.

MISSILE DEVELOPMENT TEST	TEST LOCATION
Missile External Protection	TBD
Plume-Induced Reentry Vehicle (RV) Force Test	AEDC
Missile Model EMP Test	KAFB
Missile Scale Model Subsonic/Trans-sonic Wind Tunnel Tests	AEDC
Missile Supersonic Wind Tunnel Test	AEDC
Guidance and Control/Thrust Vector Control Integration	Contractor and AEDC
System-Generated EMP Replacement Current Test	TBD
Stages I-II Interstage Structural Load Integration Test	TBD
Stages I-II Staging Test	TBD
Stages II-III Interstage Structural Load Integration Test	TBD
Stages II-III Staging Test	TBD
Stages III-IV Interstage Structural Load Integration Test	TBD
Stage IV/G&C/IFSS Integrated Dynamic and Static Test	TBD
Stage IV Reentry System Structural Load Integration Test	TBD
MX Modal Survey	TBD
Stages III-IV Staging Test	TBD
Stage I Transportation and Handling Test	Contractor
Stage II Transportation and Handling Test	Contractor
Stage III Transportation and Handling Test	Contractor
Stage I, Stage II, Stage III, and Stage IV Destruct Tests	AFRPL
Ordnance Induced Shock Tests	TBD
Stage IV Transportation and Handling Test	Contractor
Canister Pad Separation Tests	TBD
Missile/Canister Ground Shock Drop Test	TBD
EMP Missile System Test (Full-Scale Missile)	KAFB

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Abbreviations:

AEDC—Arnold Engineering Development Center (Arnold Air Force Station, Tennessee)
AFRPL—Air Force Rocket Propulsion Laboratory (Edwards Air Force Base, California)
EMP—Electromagnitic Pulse
G&C—Guidance and Control
KAFB—Kirtland Air Force Base (New Mexico)
SMF—Stage Modification Facility
TBD—To be determined

Source: SAMSO, 1977.

- Arnold Engineering Development Center, Arnold Air Force Station, Tennessee
- Air Force Rocket Propulsion Laboratory, Edwards Air Force Base, California
- Kirtland Air Force Base, New Mexico

In all cases, MX testing will represent a continuation of ongoing activities at the facilities.

Arnold Air Force Station. The integrated test plan for the MX weapon system describes five tests for the missile system which will be conducted at the Arnold Engineering Development Center, Arnold Air Force Station, Tennessee. These tests are the Plume-Induced Reentry Vehicle Force Test (T2), the Missile Scale Model Subsonic/Transonic Wind Tunnel Test (T5), the Missile Supersonic Wind Tunnel Test (T6), the Guidance and Control/Thrust Vector Control Integration Test (T7), and the Stage IV Guidance and Control/Instrumentation and Flight Safety System, Integrated Dynamic and Static Test (T14).

Test T2 will determine the Stage IV attitude control engine plume-induced forces and moments on deployed reentry vehicles. A test chamber will be used which can maintain a very high simulated altitude in order to achieve a low pressure exhaust flow in front of the post-boost vehicle where the deployed reentry vehicle is located. The simulated altitude must be maintained for a sufficient time period to obtain steady-state force and moment data on the reentry vehicle. The attitude engine plume flow field will be simulated as closely as possible by duplicating the exhaust gas characteristics and the type of boundary layer at the forward edge of the post-boost vehicle wafer.

Test T5 will determine force and moment characteristics, pressure and airload distribution, roll-torque and roll-control effectiveness, and other features of the missile at subsonic and transonic speeds. An existing 0.0825 scale model of the MX will be used for force and pressure testing. New models will be constructed for roll-control tests. Data will be obtained for a final MX configuration at angles of attack up to 90°.

Test T6 will determine supersonic force and moment characteristics and pressure and airload distribution data for the final MX configuration. The supersonic effectiveness of the missile roll-control system will also be determined. Trajectories will be determined for hardware ejected at staging, and forces and moments will be determined on both the missile stages during staging. Either the existing or a new model will be used, depending on requirements determined at a later date. High pressure air will be supplied in the wind tunnel which is selected for final testing.

Test T7 will determine that the guidance and control electronics and each stage actuator interface meets system performance requirements in a hot-firing environment. Also, the interfaces between guidance and control and the stage actuators will be examined, and the nozzle and control system response and performance will be determined. All four missile stages will be tested along with their guidance and control flight electronics. A test stand facility will be used during these tests.

Test T14 will determine the thermal and dynamic environment of the guidance and control and instrumentation and flight safety systems equipment during Stage IV Dynamic and Static Testing. The structural adequacy of these systems and the interface with Stage IV will be verified. These tests will be conducted in a chamber which will simulate the desired altitude.

Edwards Air Force Base. The integrated test plan for the MX weapons system (SAMSO, 22 June 1977) describes one test conducted at the Air Force Rocket Propulsion Laboratory at Edwards AFB in the Mojave Desert of southeastern California. This test is identified as T22 and is known as the Stage I, Stage II, Stage III, and Stage IV Destruct Test. Other tests described in the integrated test plan which have not yet been assigned a specific testing site may also be conducted at the Air Force Rocket Propulsion Laboratories at Edwards AFB, including two major testing programs for compatibility, to evaluate performance of stage and flight termination ordnance subsystem components, and to demonstrate stage destruct characteristics. Each of the stages will be tested separately, and, except for Stage IV, fuel will not be detonated. High-speed camera coverage will be used to record destruct characteristics. Tests will be held in a remote access controlled area of the Rocket Propulsion Laboratory facilities, but the exact locations have not yet been determined.

Kirtland Air Force Base. Several tests supporting full-scale engineering development of the MX system will be conducted at Kirtland AFB, which is adjacent to Albuquerque, New Mexico. Electromagnetic pulse (EMP) tests scheduled for Kirtland AFB are identified as T3, the Missile Model EMP Test, and T42, the EMP Missiles Systems Tests on the full-scale missile. Other tests scheduled for Kirtland AFB presently are identified by the facilities required. These are the advanced research electronic simulator test facility, the instrument and flight safety system control and monitor console, the instrument and flight safety system test site support equipment, the ground test missile instrument and flight safety system, the ground test missile instrument and flight safety system antenna subsystem, the missile test stand, the pulse data acquisition system, the prototype guidance and control drawer, the ground test missile reentry system (active), the ground test missile

reentry vehicle, the ground test missile Stage I, the ground test missile Stage II, the ground test missile Stage III, and the ground test missile Stage IV. The precise nature of most of these tests has not yet been specified.

The objectives of the missile model EMP tests are (1) to determine the EMP-induced current flow to missile cables and shielded subsystems, and (2) to determine the effect that the conducting engine exhaust plume gases have on the induced cable currents and shielded subsystems for each staging configuration. The size of the missile model which is used for these tests will be subject to the physical test area and frequency spectrum available in the selected EMP simulator. Also, the magnitude of the EMP drive levels will be subject to the selected simulator. The test objectives of the EMP missile system test at full-scale will be as follows.

1. Obtain EMP response data on a full-scale MX ground test of mission critical circuits to enable accurate estimation of MX survivability in all phases of flight to simulated threat level high altitude bursts. EMP response data shall include synergistic effects of vibration, source region conductivity, plume, and ionizing radiation.
2. Obtain data required to verify the system level coupling models, including missile skin currents, plume currents, cable shield currents, and critical individual wire currents and voltages.
3. Obtain data for critical end item EMP specifications in a system environment such as transfer functions and source and load impedances.
4. Evaluate the effectiveness of nonlinear protective devices in place.
5. Evaluate missile hardness to simulated EMP near-threat level environment by means of demonstration tests to functioning systems.
6. Provide baseline data for the Hardness Surveillance Program.

During these tests, the ground test missile electronics shall be operating in the flight mode. All operational electronics for the ground test missile will be required. Transportation and handling equipment and maintenance support equipment and test support equipment, including EMP simulators, will be necessary for the testing. (SAMSO, 22 June 1977)

ELEMENTS OF FULL-SCALE ENGINEERING DEVELOPMENT
WHICH MAY AFFECT THE ENVIRONMENT

This section is primarily focused on design and production of full-scale missile and transporter prototypes, and testing of components. Some, but not all, aspects of each of these activities have the potential for environmental impacts. This section identifies the major aspects of each activity which may affect the environment and notes why other aspects were determined to not have this potential.

New facilities may be required at a variety of locations. At a minimum, the following facilities have been identified as necessary at Vandenberg AFB.

- launch pad facilities (2)
- rail transfer facilities
- mechanical maintenance facilities
- integrated test facilities
- payload assembly building
- stage modification facilities (3)
- stage storage pads (3)
- stage IV processing facility
- missile assembly building
- basing mode facilities

These are all described in detail in the Vandenberg portion of this Environmental Impact Statement (Volume III).

Another facility under consideration is a mid-course range safety facility somewhere in the Hawaiian Islands. This facility would probably consist of several buildings to house computers (telemetry, tracking, and data-processing equipment), control centers, and command radio transmission equipment.

Various additional facilities may be required at contractor manufacturing areas and at contractor and government testing facilities. The exact nature of these minor support facilities has not yet been determined.

Modification of Existing Facilities

In many cases, it will be possible to utilize existing facilities for MX manufacturing and testing. Selected contractors will require relocating for MX manufacturing, but this will probably be housed by existing facilities. Modifications to test facilities are also projected to be minor, since MX requirements are in line with the current mission of test facilities as described below.

- Vandenberg Air Force Base. Vandenberg Air Force Base is the planned location for the flight testing of certain basing mode tests. This testing phase, utilizing complete prototype missiles and associated hardware, includes not only ground testing, but also approximately 20 missile flight tests from an operationally configured basing mode.

  Although historically Vandenberg has undergone many test programs, MX testing is expected to require primarily new facilities. It is anticipated that only two of the support facilities, the payload assembly building (PAB) and the Stage IV processing facility, will be housed in existing but modified structures.

- Edwards Air Force Base. The Air Force Rocket Propulsion Laboratory (AFRPL) at Edwards Air Force Base, California, is the planned location of Stage I, II, III, and IV destruct systems. Test objectives are demonstrations of characteristics and performance evaluations of each stage's flight test destruct system (FTDS). Thus, a remote, access-controlled test area is required.

  Numerous facilities exist for research and development; for flight testing of new and experimental aircraft; and for testing of experimental propulsion and ordnance systems. Full-scale development would be expected to place few additional demands on preexisting facilities. Modifications of existing facilities might be necessary for stage destruct system pre-test inspections and post-test evaluations, but such alterations would be expected to be minor.

- Arnold Engineering and Development Center. The Arnold Engineering and Development Center (AEDC), located at Arnold AFS in Tennessee, is the planned test center for missile scale model subsonic, transonic, and supersonic wind tunnel tests; guidance and control/thrust vector control integration; and for integration of static and dynamic tests upon Stage IV guidance and control/instrumentation flight safety systems. Wind tunnel tests are designed to determine the effectiveness of the missile's roll-control system, as well as assess force and airload distributions as air pressures change. Guidance and control tests will determine whether the electronic guidance components, together as a subsystem, meet technical and safety specifications during an actual test firing.

Numerous facilities exist for wind tunnel, and for static and dynamic jet and rocket component testing, analysis, and evaluation. Additional demands placed upon AEDC's facilities by MX full-scale development would be expected to be relatively small, although some modifications of existing facilities to accommodate unique MX test characteristics may be necessary.

- Kirtland Air Force Base. Kirtland AFB, New Mexico, is the planned location of both model and the full-scale missile electromagnetic pulse (EMP) tests. These tests will be conducted to estimate induced electrical currents in missile skin, cable shields, and electrical cables, and to verify that systems/subsystems meet shielding requirements.

  Because of its specialization in nuclear effects, Air Force Weapons Laboratory (AFWL) has been chosen to provide selected nuclear hardness and survivability simulation tests as well as serve as host base for EMP testing for MX.

  Nuclear weapons effects studies have been performed at AFWL; thus, existing facilities would be expected to be able to supply some of MX test requirements. However, full-scale missile EMP tests will require assembly, ground test, and verification facilities larger than for previous studies. This, as well as other unique MX characteristics, will necessitate some facility modifications. Upon further test definition, these modifications will be detailed.

Requirements for Modification of Existing Land Use

While some land-use modifications may be necessary as a direct result of full-scale engineering development of the MX system, these are for prototype production and may require the selected contractors to modify or expand existing facilities, thus intensifying current uses. A comparable situation exists at both government and contractor test sites. These modifications and expansions, if they occur, will be compatible with adjacent land uses and are not expected to be significant.

The on- and offbase uses of land near the government-owned test sites are briefly described below.

- Arnold Air Force Station. Activated in 1950, Arnold AFS is the site of the Arnold Engineering Development Center (AEDC), the nation's largest complex of wind tunnels, jet and rocket engine test cells, space simulation chambers, and hyperballistic ranges, used to test new aerospace systems.

  Located midway between Chattanooga and Nashville, Tennessee, near the city of Tullahoma, this 40,000-acre (16,000 ha) base has moderately rolling topography ranging between 900 ft and 450 ft (274 and 137 m) above sea level. The natural vegetation of the

undeveloped area is thick underbrush and pine forests, which harbors many wild species, including deer and wild turkey, which are hunted to hold down their population.

The base employs about 3,200 military and civilians with an annual payroll of about $63.8 million. Tullahoma, just west of the base, had a 1970 population of about 15,300 and has realized the benefit of the base's large payroll and relatively high employee income (average just under $20,000 per year).

- Kirtland Air Force Base. Activated in 1941, the Kirtland AFB's primary function presently is to provide contract management; nuclear and laser research, development, and testing; operational test and evaluation services; and some relatively minor air activity.

  Located on the south side of the city of Albuquerque, New Mexico, this 54,000-acre (21,600 ha) base is relatively flat, at an elevation of 5,352 ft (1,632 m) above sea level. Little of the original natural vegetation remains on the base. However, the Isleta Indian Reservation on the south side of the base is still very much in its natural high plateau state. The base employs about 9,200 personnel, military and civilian, with an annual payroll of $210 million. In addition, the 6,000 personnel of Sandia Laboratories are located at the base. The city of Albuquerque, the largest in New Mexico, had a 1970 population of about 244,000 and enjoys benefits of the large payroll of the base. About one family in eleven in the city is directly associated with Kirtland.

  Electric power, water, gas, sewage disposal, and solid waste disposal service is provided by public utilities in the area. No air quality or noise problems are caused by the nonaviation operations at the base.

- Edwards Air Force Base. Activated in 1933, this vast 300,000-acre (120,000 ha) Air Force reservation is the site of the Air Force Flight Test Center whose primary mission is to conduct research and development flight testing for manned and unmanned aircraft systems. The test pilot school there is also an important function.

  Located in the west end of the great Mojave Desert, Edwards AFB lies about 30 mi (48 km) north of Lancaster, California. The base has two dry lakes with a total of 25,000 acres (10,000 ha), any part of which can be used for landing aircraft.

  The base employs 8,600 military and civilian personnel, and the annual payroll is $134.2 million. The communities of Lancaster (1970 population of 32,000) and Edwards (1970 population of 10,300) are where most of the base personnel reside. The base is the source of the greatest income in the area.

Declining visibility in the Antelope Valley is becoming a serious problem to flight testing, and a study of the problem is presently being conducted to determine solutions. Base water requirements are met through on-base deep wells, but most other utilities are supplied by public agencies; however, sewage and solid waste are disposed of on the base. Because it is in a natural low area, there is a growing problem of groundwater quality.

KEY ISSUES

National Level Key Issues

The key issues involved in full-scale engineering development of the MX system can generally be grouped into three levels of aggregation: national, regional (defined as state level for analysis), and site-specific effects predominantly related to testing and validation activities.

Three key issues have been identified at the national level: competition for labor resources, competition for natural resources, and the allocation of money.

Costs to date and projections of additional costs prior to the Milestone II decision are summarized in Table I-2. These data are the most current estimates available and indicate total expenditures of $316 million for advanced development. Costs already incurred amount to $162 million with $134 million budgeted for fiscal year 1978.

Projections of costs for full-scale engineering development are being prepared as part of current planning efforts oriented toward a Milestone II decision. A wide range of estimates is necessary, since several key cost-related decisions (such as choice of basing mode) have not been made to date. In hearings before the House Armed Services Committee, the Air Force estimated full-scale engineering cost totals in the vicinity of $6.7 billion (House Committee on Armed Services, 1977). A recent analysis estimated full-scale engineering development costs to include $3.7 billion for missile RDT&E and $1.2 billion (1977 dollars) for basing mode RDT&E or a total of $4.9 billion. A third and most recent estimate, prepared for the U.S. Congress by the General Accounting Office, is for full-scale engineering development costs of approximately $5 billion.

This statement analyzes environmental impacts based on FSED expenditures ranging from $5 billion to $7 billion. However, total costs may vary substantially from these estimates. Alternative missile transporters may differ in cost between surface and underground modes, additional engineering analysis may be required to overcome unanticipated problems if fewer prototype missiles are required. Unit cost may increase while total costs decrease.

Table I-2. MX advanced development cost estimates, fiscal year 1974-1979 (1977 millions of dollars).

EXPENDITURE CATEGORY	FISCAL YEAR			TOTAL
	1974-1977	1977	1978	
Air Mobile Basing	7.5	—	—	7.5
Propulsion	32.3	5.8	12.9	51.0
Performance and Software	2.8	1.0	2.8	6.6
Guidance and Control	43.8	21.8	29.0	94.6
C^3, Physical Security, and Ground Power	0.1	2.7	7.0	9.8
Missile Transport and Launch Vehicles	0.7	9.3	13.6	23.6
Canister	2.5	1.3	1.1	4.9
Buried Trench	—	4.7	16.0	20.7
Shelter Closure	—	5.2	2.7	7.9
Siting/Shelter Design	2.2	5.6	4.0	11.8
Environment	—	1.7	4.4	6.1
Vulnerability and Hardness	0.1	5.4	6.8	12.3
Systems Engineering and Management Support	0.9	4.5	32.1	37.5
Reentry Vehicle	—	—	2.0	2.0
Total	92.9	69.0	134.4	296.3

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Source: General Accounting Office, 1978.

In spite of these data uncertainties, $5 billion appears to be a reasonable estimate of full-scale engineering development costs.

Full-scale engineering development is tentatively scheduled to require 4 years and 9 months and would thus involve annual expenditures averaging about $1 billion per year. Peak year expenditures may be higher, perhaps as high as $1.5 billion. Monies to pay full-scale engineering development costs will come from federal revenues; as allocated to MX, they are unavailable for alternative uses.

Full-scale engineering development monies (including prototype missile production, basing mode specialization ground vehicles, component and full-scale testing and system testing) will be used to

purchase labor and natural resources. Direct labor, i.e., workers in aerospace and related industries, has recently been characterized by relatively low employment levels and some recent slow recovery. Many previous workers have transferred to other industries. Development of MX will create a demand for some unemployed or alternatively employed aerospace qualified workers to reenter the industry as well as additional competition among aerospace companies for currently employed workers.

State Level Key Issues

At the state or regional level, key issues focus on population migration resulting from the creation of new jobs and growth constraints in the states. The aerospace industry employment is heaviest in California; thus, much developmental work will occur there. However, several other states are of particular importance due to concentration of guidance system, transportation system, and propulsion system related industries. While almost every state in the nation will experience some economic growth resulting from full-scale development of MX, that portion related to development of prototype missiles and missile transporters will be concentrated in the following states:

- California
- Washington
- Colorado
- Utah
- Massachusetts
- New York/New Jersey/Connecticut
- Texas

Four growth-related effects have been identified as of primary importance:

- water demands
- energy demands
- atmospheric emissions
- new jobs generated

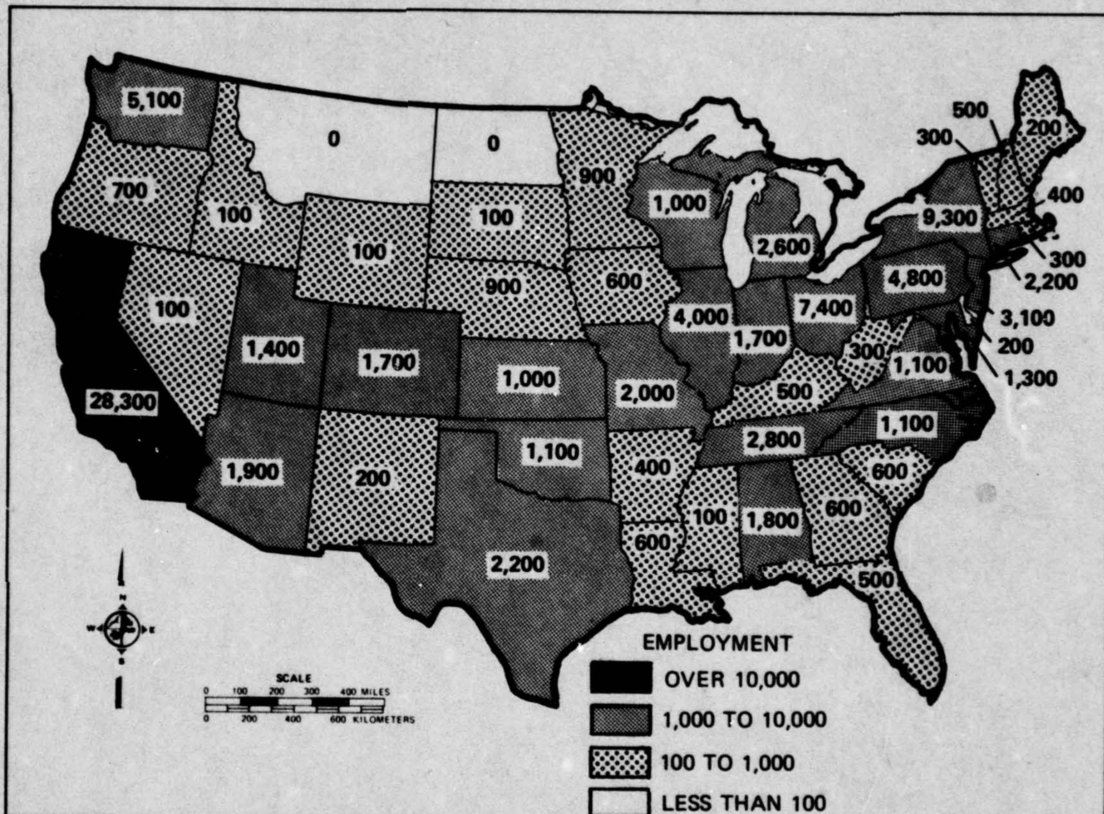
The number of new jobs required for MX is substantially more than those directly working on the project. Business and households will supply goods and services directly to the project, will be paid, and, in turn, will demand goods and services from other business and households. The secondary suppliers will, in turn, rely on other suppliers . . . and so on through the economy. These successive rounds of interindustry and

household consumption made up the indirect-induced component of the total economic effect.

Test Site Key Issues

Various tests of MX components, subsystems, and models have been scheduled at Arnold AFS, Tennessee, Kirtland AFB, New Mexico, and Edwards AFB, California. Key environmental issues associated with the tests assigned to these locations are minimal because, in most cases, the facilities for testing are already operating and are designed to be environmentally acceptable.

Noise and atmospheric emissions are the major potential environmental issues associated with tests involving rocket motor firings or detonations. In all cases, these types of tests will be conducted in isolated, access-controlled areas or in completely controlled environments, where all applicable environmental and safety regulations will be met. Potential EMP interference with electronic equipment is a possible issue at Kirtland AFB. However, other EMP tests for major weapon systems have been conducted there, and environmental analyses have concluded that the isolation of test sites is sufficient to provide adequate protection.



Project and Environment

1
THE PROJECT AND THE ENVIRONMENT

1.1 PROJECT OBJECTIVES OF FSED

The overall objectives of full-scale engineering development are to evolve a weapon system that will meet all defined mission objectives at an acceptable cost. Full-scale engineering includes:

- Manufacture of prototype missiles and ground support equipment
- Component and flight testing
- System validation testing

These main divisions are reflected in the organization of this chapter. Section 1.1.1 describes the systems to be developed, Section 1.1.2 describes the production of prototype missiles and facilities while Section 1.1.3 describes validation and testing of the system.

Engineering Development of Full-Scale Systems (1.1.1)

This section describes the major items that must be designed, developed, and fabricated or constructed during the full-scale engineering development phase. Detailed information beyond that given here on many items is classified for military security.

Missile Systems Component Development (1.1.1.1)

Reentry System. The reentry system (R/S) is the portion of the post-boost vehicle (PBV) that carries the reentry vehicles, penetration aids, and a deployment module.

The reentry vehicles (RVs) are the nuclear weapons carried by the missile. Penetration aids (Pen Aids) are such items as decoys or radar-reflecting materials ("chaff") that can be dispensed to increase the probability of successful penetration of the enemy defense. The deployment module provides means for mounting the reentry vehicles and directing them against their designated targets, and for releasing penetration aids.

Guidance and Control System. The guidance and control system consists of:

- An Advanced Inertial Reference Sphere (AIRS), which provides a space-stabilized reference for the sensors used to determine the trajectory of the missile through space.
- Third generation gyroscopes (TGG) that sense rotational motions and maintain the orientation of the AIRS.
- Specific Force Integrating Receivers (SFIR), that sense the path of the missile through space.
- A computer that stores trajectory and target information, and has a remote retargeting capability. In flight, it receives information from the motion sensors and generates outputs to control the trajectory, separate stages, terminate third-stage burn for short ranges, actuate the fourth-stage motors to provide programmed space positions and attitudes, and dispense the RVs and Pen Aids.
- Actuators to control the thrust directions of the three boosters and the impulses of the small control motors on the PBV.

Post-Boost Propulsion System. The Post-Boost Propulsion System (PBPS) has a number of small rocket motors that can be used to control the attitude of the Post-Boost Vehicle (PBV) in roll, pitch, and yaw, and can also be used to extend the range over that provided by the first three stages. It is powered by liquid bipropellants which ignite when mixed.

Boost Stages. The three boost stages are solid propellant rocket motors, with lightweight synthetic fiber (Kevlar) or fiberglass motor cases. Missile flight stability requires a large nozzle for the first stage, with a high rate of change in the thrust deflection angle and a large total deflection. In addition to advanced movable nozzles, the second and third stages have extendable nozzle exit cones, giving a shorter missile than would be possible with fixed cones.

The main stages (I and II) will use a propellant composition that principally presents only a fire hazard. The other two stages will use a propellant that provides improved performance, but can explode.

Ordnance. Stages are separated by explosive cutting cords. The cords are actuated by bridgewires, which explode when subjected to a high electric current but are otherwise inert for safety.

Instrumentation and Flight Safety. Aerospace Vehicle Equipment (AVE) for the Instrumentation and Flight Safety System (IFSS) will be carried in the post-boost vehicle for flight tests. (Additional equipment is also required on the ground.) The IFSS stores and transmits flight data, and permits flight termination on command when required for safety. Extensive tests with a ground test missile will be conducted, and formal approval by the Range Safety activity is also required before the first flight. Compatibility and integration tests with actual flight hardware are also required.

Electronics. In addition to the electronics associated with the inertial measurement system and computer, electronic systems are required for the boost stage controls and downstage flight controls. Power supplies are also required for the various electronic systems.

Missile System Fabrication Development Assembly and Integration Development (1.1.1.2). The missile system will be fabricated in six separable units:

- A dust-hardened ascent shroud, which covers the post-boost vehicle. (This unit is jettisoned after second stage burnout.)
- The reentry subsystem
- The remainder of the Post-Boost Vehicle
- Three solid-propellant booster stages

Conceptually, the missile is assembled in its canister in the Missile Assembly Building (MAB) by:

1. Installing the canister in a vertical position within the MAB, in a location with a working platform at the top of the canister.
2. Lowering the first stage into the canister with an overhead crane until its top is at an appropriate level with respect to the working platform, and holding it in place with an air elevator.
3. Emplacing the second stage on the first stage, where they are mated by an assembly team.
4. Lowering the two mated stages, and repeating the process with the third stage.

5. Lowering the three mated stages, and repeating the process with the PBV.
6. Emplacing the shroud.
7. Lowering the complete missile into the canister, removing the air elevator, and checking out the missile.
8. Installing the cold-launch system and nozzle closure, with appropriate additional checkouts.
9. Transfer of the canisterized missile to the appropriate transport or launch vehicle.

Missile integration during full-scale engineering development will be the responsibility of the AT&SS contractor. These activities will occur at Vandenberg Air Force Base prior to flight tests. Their scope will be determined by the nature of the problems encountered.

Ground System Development (1.1.1.3)

Ground System Components

Ground Electronics. Ground electrical and electronics systems required include all elements of the:

- Command, Control and Communications System
- Physical Security System
- Power System

Details of the systems to be developed will vary with the basing mode selected, and the results of continuing cost/performance (trade) studies. Among the functions to be provided are:

- Redundant communications with National Command authorities and the Strategic Air Command (SAC).
- Status monitoring, retargeting, and launch control systems for the missiles.
- Message coding and decoding (cryptographic) systems
- Movement command systems
- Internal communication systems
- Security sensors and monitoring systems
- Access control systems for high security areas
- Normal, emergency, and post-attack electrical supply systems
- Test equipment

A complete description of all required electronic systems is beyond the scope of this environmental statement.

Facilities. The following types of facilities will be designed during full-scale engineering development:

- Test facilities for the missile flight test and basing mode evaluation program
- Prototype and final aimpoints (buried trench, selected shelter as appropriate)
- Roads and utilities
- Technical support structures (missile assembly building, alert maintenance facility, security alert facility, etc., required for deployment of the system in the selected mode at the selected site).

Nuclear H/S. Nuclear hardness and survivability (H/S) studies and tests will be conducted during full-scale engineering development to establish the final criteria to be applied in the design of ground systems, and to test;

- The effects of nuclear airblast, shock, electromagnetic pulse, and debris affects on system operation
- Vehicle shock motions in response to an attack.

These tests will use appropriate simulation methods; detonation of nuclear weapons is not required.

Ground Vehicles. Ground vehicles appropriate for the selected basing mode will be developed during full-scale engineering development. The general types of vehicles required were described in Volume I. Vehicle characteristics vary substantially with basing mode, from the single transporter/emplacer used with the vertical shelter to multiple (and more complex) vehicles for use in the other options including the blast plugs, transporter/launcher, and a transport vehicle in the buried trench concept (Figure 1-1).

Training Programs. Extensive training programs are required for effective operation of a weapons systems on the scale of MX. The full-scale engineering development phase will consequently include:

- Development and continuous updating as necessary of a comprehensive training plan

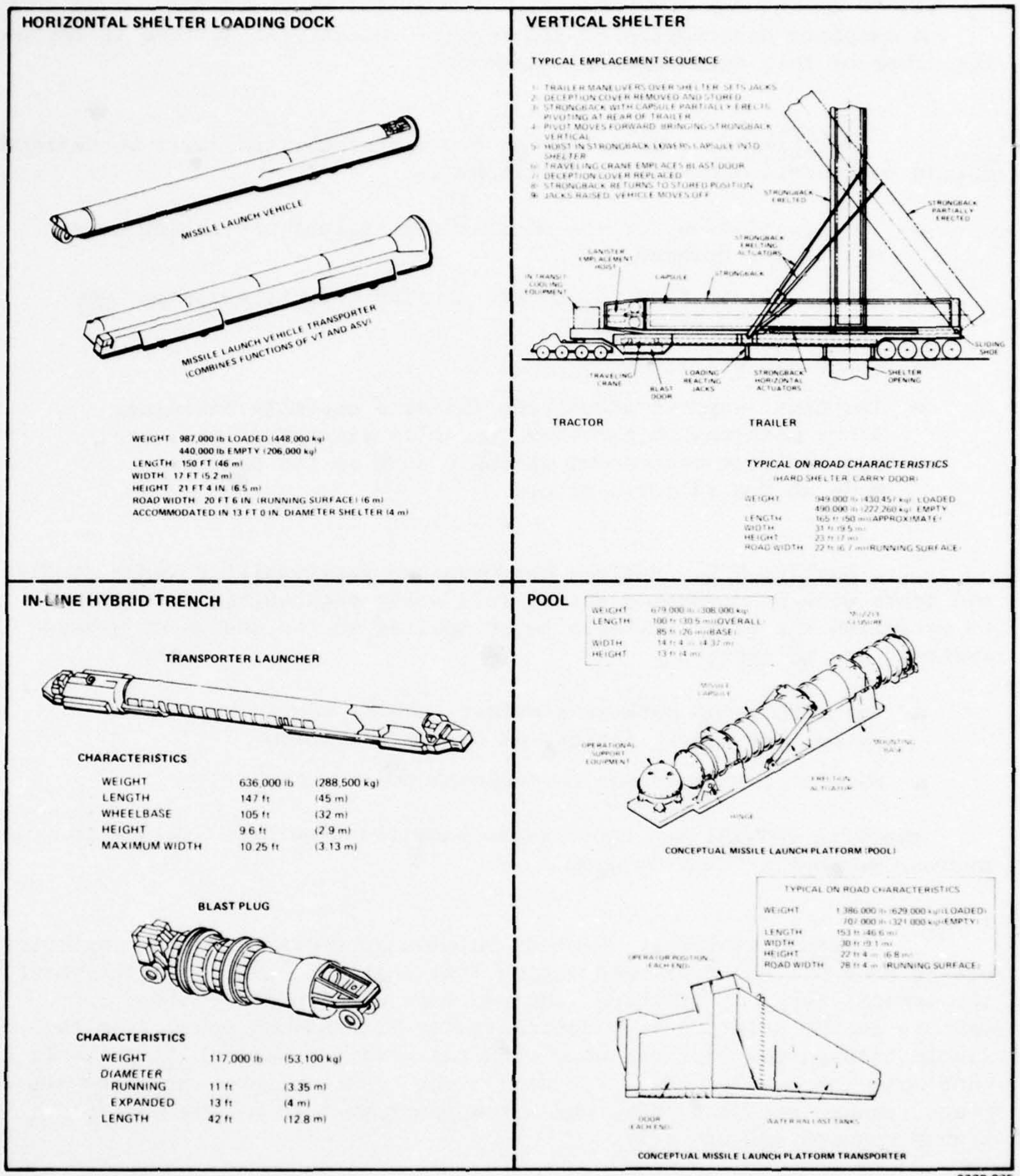


Figure 1-1. One or more of the alternative mobile vehicles will be constructed and tested as part of FSED.

- Development of performance requirements for training equipment, with updates as required
- Design and development of training equipment
- Design of training facilities (these facilities will not be constructed under FSED)
- Development of training courses, and initiation of Operational Test and Evaluation Training of Strategic Air Command (SAC) personnel

Ground Systems Fabrication, Assembly, and Test

Ground Electronics. Ground electronics systems will be fabricated in sufficient numbers to support the planned flight and basing mode test programs. Separate components will be tested at the factory to assure that they meet all specified requirements of the contract, and shipped to the test sites where they will be assembled into functional systems.

Ground Vehicles. Ground vehicles will be fabricated, assembled, and tested at the responsible contractors' facilities to assure that they meet the specified requirements. They will then be disassembled into the minimum number of units necessary to meet shipment weight requirements, and transported to the test site, where they will be reassembled. Both missile-launch and basing mode compatibility will then be established in the planned test program.

Security Systems. Security system components will be fabricated, assembled, and tested at the responsible contractors' facilities to assure that they meet the specified requirements. They will then be shipped to the test sites, where they will be assembled into functional systems.

Production of Missiles (1.1.2)

Full-scale engineering development contractual awards are scheduled for 1979, with subsequent development manufacture and test programs over approximately 5 years. This statement analyzes environmental impacts based on FSED expenditures ranging from $5 billion to $7 billion. Depending on the basing mode, system costs, including research and development, production, testing, procurement, operations and support are estimated to be approximately $20 billion to $30 billion for an operational MX ICBM force between 200 and 250 missiles. As a baseline, the vertical shelter basing mode with point security and 200 missiles is estimated to cost approximately $25 billion (FY 78 Dollars).

Design, manufacture, and testing of MX components, subsystems, and to a lesser extent, testing of complete prototype missiles, will be

concentrated in areas with industrial specialization in aerospace. In particular, production will be centered around firms which manufacture airframes; casings; propulsion units; transmitting, receiving, detection and other electronic equipment; ground transport equipment; as well as test and control instruments and equipment. Aerospace firms by themselves are concentrated in 20 states; most of this industrial specialization is centered in California and Washington. Direct support industries are located across most of the United States; most states could receive some spillover effects, the extent of which is determined by their industrial economies.

Validation and Testing (1.1.3)

Testing activities will be conducted at increasing levels of complexity as the full-scale engineering development program moves from design and development of individual components and assemblies to production and integration of complete subsystems (e.g., the missile proper). Flight tests will also be made of the missile (Volume III).

The test program has the ultimate aim of assuring that MX will meet the mission need if produced and deployed. Among the factors considered are subsystem compatibility, performance, reliability, ability to survive under the expected environment (including that imposed by nuclear attack), and that the system can be operated and maintained at the established level of readiness to meet objectives.

Tests begin at the component and assembly level, normally conducted at the responsible contractor's facilities to assure that the items meet contractual requirements. Some tests, particularly those requiring highly specialized equipment, are conducted using Government facilities. Among these are wind-tunnel tests, those for evaluation of nuclear effects, and destruct tests of main-motor stages. Still other tests involve the construction and operation of special facilities. Among these are the flight-test facilities at Vandenberg Air Force Base (Figure 1-2).

Missile (1.1.3.1). The missile test program is well-defined at this time, since the characteristics of the missile are reasonably well known. Extensive analysis and test requirements are defined in the ICBM Program Office Engineering Directive for the Integrated Test Plan for the MX Weapons System.

That document defines three categories of tests:

- Configuration item (CI) tests, conducted by each contractor to investigate design approaches and relations, to conduct flight proof tests, and to qualify individual end items. (Tests at this level are too varied and numerous to include in the Integrated Test Plan.)

- Integration Tests, where two or more contractors will require combined tests to evaluate their hardware/software. Initial integration tests can involve early hardware, and be conducted informally by the contractors concerned. Later integration tests, involving software and prototype hardware, are in accordance with formal, documented procedures.

- System tests, which involve two or more "subsystems" (defined as the equipment, or software, developed at the Associate Contractor level) developed to the full prototype-hardware level, and requiring complete, formal documentation.

The test activities include many factors, such as scaled tests in wind tunnels and high-altitude chambers, missile environmental factors (physical and radiation protection at all levels), mechanical and functional compatibility of major assemblies, C^3 interconnections, transportation and handling factors, stage destruct tests, complete assembly tests, ejection tests, instrumentation and flight safety tests, and actual flight tests (short-term and full-scale). Associated with the flight tests will be tests of the reentry system (with simulated RVs).

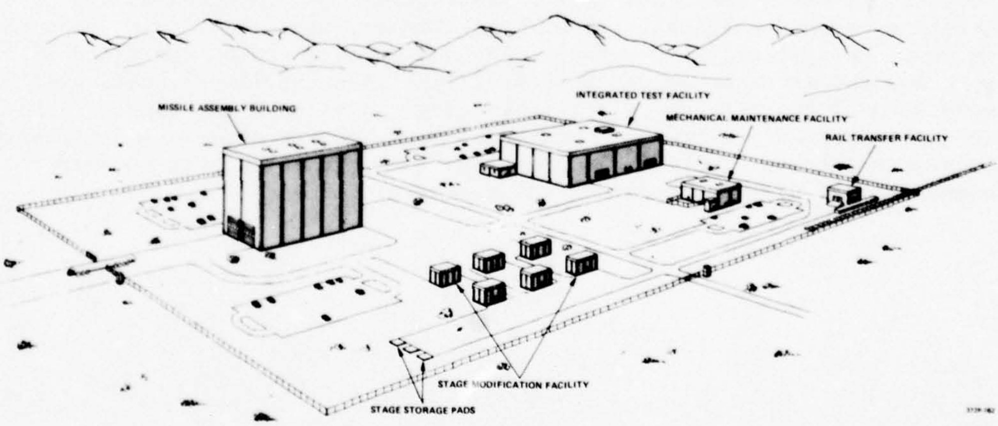


Figure 1-2. Full-scale engineering development will include construction of assembly and launch facilities for one or more basing modes at Vandenberg Air Force Base, California. Environmental analysis of the facilities' construction and flight tests at one of four alternative locations is included in Volume III of this FEIS.

Ground Equipment (1.1.3.2). Tests of the ground equipment cannot be established in detail until the basing mode decision at Milestone II establishes overall direction of the FSED program. Configuration item and integration tests will be required for the ground electronics (C^3, security system, electrical systems, etc); vehicles; and assembly and maintenance equipment, as necessary. Complete test plans will be developed based on those current documents for the missile and systems tests of major elements.

Multiple Aimpoints (1.1.3.3). Full-scale tests will be required for the selected multiple aimpoint configuration during FSED, so that a final design can be chosen and deployed. These tests include not only the aimpoints proper, but prototype transporter/launchers (or equivalent, for aimpoints not using a TL), operational support equipment, and complete ground-test missiles. Planned tests include in-place simulation of electromagnetic pulse effects, airblast, shock, and debris on system integrity, and the response of the vehicle(s) to shock motions. These tests are principally concerned with nuclear hardness and survivability.

Nuclear Hardness and Survivability (1.1.3.4). In addition to the nuclear H/S tests described above, testing will be conducted at all levels to assure survivability of all elements, from electronic components to complete systems. For example, EMP and self-generated EMP tests will be conducted with the ground-test missile, laboratory-level tests will be conducted of the effects of attack-induced radiation, dust pebbles, and ice on in-flight performance, and upon shock and vibration. Additionally, underground tests of critical components in conjunction with nuclear weapons tests will be conducted as necessary.

1.2 THE ENVIRONMENT RELATED TO PRODUCTION OF PROTOTYPE MISSILES

Development of the MX systems will have social and economic effects that are national in scope. Decades of experience with aerospace development have shown that the resulting employment, income, research, and new technological development have stimulated economic activity throughout the entire nation. Similarly, costs have been incurred throughout the country. Therefore, at the aggregate level, the entire nation is analyzed to anticipate national effects that might result from full-scale development of the MX system.

These effects are not evenly distributed. Areas with industrial specialization in aerospace have experienced a disproportionate share of benefits when programs are developing. These benefits include output, earnings, and employment. Secondary benefits such as technological development and national prestige accrue to each resident of the country. Areas of aerospace concentration have potential to incur most of the costs when programs terminate for whatever reason.

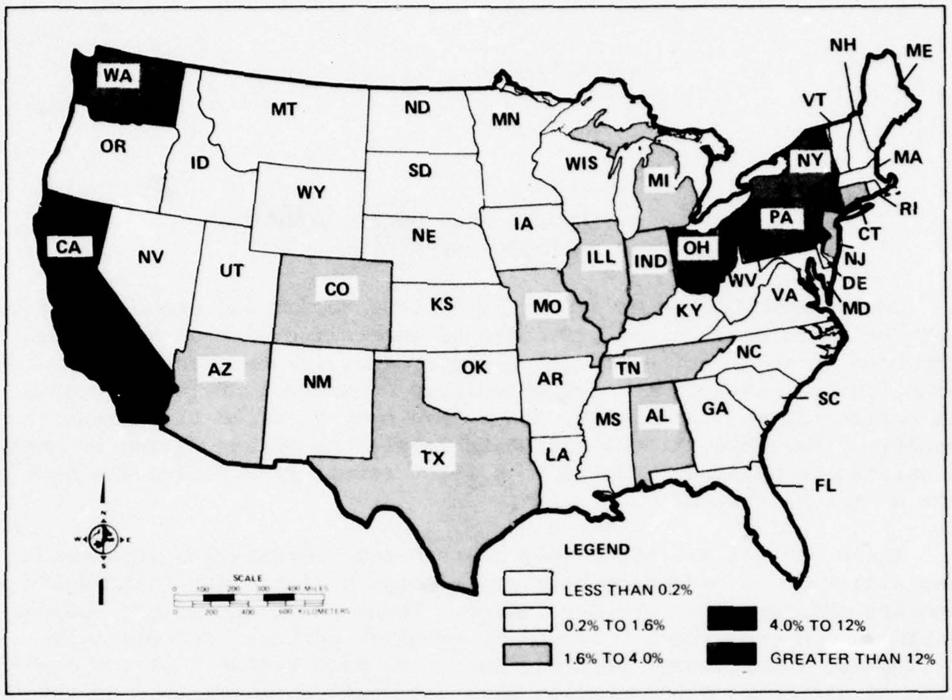
Identification of Analysis Areas (1.2.1)

Full-scale engineering development of MX will draw on support industries in addition to aerospace. These support industries include guidance, ordnance, transportation, communication and propulsion. Figure 1-3 demonstrates that, based on employment, components of these industries are located in almost every state in the nation. Major direct contracts for full-scale engineering development will focus on those states where suppliers with the requisite size and experience exist. Detailed analysis of potential supplier industries has indicated that direct full-scale engineering development contracts will be concentrated in seven areas:

California - the single greatest concentration of aerospace and support industries in the nation.

Washington - the second largest concentration of aerospace employment in the nation.

Colorado - Aerospace and the related aircraft equipment industries are well developed in this area.



STATE	PERCENT SHARE	STATE	PERCENT SHARE	STATE	PERCENT SHARE
CALIFORNIA	27.8	MARYLAND	1.3	MASSACHUSETTS	0.4
NEW YORK	9.1	NORTH CAROLINA	1.1	RHODE ISLAND	0.3
OHIO	7.3	OKLAHOMA	1.1	VERMONT	0.3
WASHINGTON	5.0	VIRGINIA	1.1	WEST VIRGINIA	0.3
PENNSYLVANIA	4.7	KANSAS	1.0	DELAWARE	0.2
ILLINOIS	3.9	WISCONSIN	1.0	MAINE	0.2
NEW JERSEY	3.0	MINNESOTA	0.9	NEW MEXICO	0.2
TENNESSEE	2.8	NEBRASKA	0.9	IDAHO	0.1
MICHIGAN	2.6	OREGON	0.7	NEVADA	0.1
CONNECTICUT	2.2	GEORGIA	0.6	MISSISSIPPI	0.1
TEXAS	2.2	IOWA	0.6	SOUTH DAKOTA	0.1
MISSOURI	2.0	LOUISIANA	0.6	WYOMING	0.1
ARIZONA	1.9	SOUTH CAROLINA	0.6	MONTANA	0.03
ALABAMA	1.8	FLORIDA	0.5	ALASKA	0
COLORADO	1.7	KENTUCKY	0.5	HAWAII	0
INDIANA	1.7	NEW HAMPSHIRE	0.5	NORTH DAKOTA	0
UTAH	1.4	ARKANSAS	0.4		

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SOURCE: CENSUS OF MANUFACTURES, 1972.

Figure 1-3. Percent share of employment in aerospace and support industries, 1972.

Massachusetts - Electronic industries involved in guidance, security, and communications are concentrated in this state.

New York/New Jersey/Connecticut - Electronic industries in these states are well integrated and interdependent. Thus the states are treated as a unit herein.

Texas - Concentrations of electronic industries involved in guidance systems are found in this state.

Utah - An important concentration of propulsion systems industries are located in this state.

While most of the larger contracts between the Air Force and private industry will probably go to firms located in these states, secondary and tertiary contracts are expected to be let throughout the nation. To estimate the distribution of such contracting, the employment share data of Figure 1-3 have been used. As most direct contracting is expected to focus on the seven states (or state groups) listed above, the emphasis in this report is on those areas.

As noted above, flight testing will occur at Vandenberg AFB and is covered in Volume III. Three other sites for MX FSED tests have been identified and are discussed in this chapter: Arnold AFS, Edwards AFB, and Kirtland AFB.

Existing Environment in Selected FSED States (1.2.2)

The key environmental issues involved in full-scale engineering development are energy, water, air quality, and resources committed, including new jobs created. The existing environment related to each of these key issues in the seven analysis areas is discussed in the following sections.

California (1.2.2.1)

Energy. California ranks second among the full-scale engineering development states in various kinds of electric energy production and sales. Its large population and industrial base creates this extraordinary energy demand; most of the fuel used is "clean" with relatively small amounts of coal or fuel oil consumption except for power generation.

Electric. About one-third of California's electric power is created by hydro power in the High Sierra Mountain Range located in the east central part of the state and about 50 percent of the power consumed in southern California is hydro-generated (Hunt, 1974). Over 60 percent of the power generated at Hoover Dam on the Colorado River in Arizona is consumed in southern California. Because of California's strict air quality regulations and because of natural gas shortages, more and more low sulfur fuel oils need to be imported. The three largest

producers of electric power are Pacific Gas and Electric (PG&E) in northern California, Southern California Edison (SCE) and the San Diego Gas and Electric Company (SDG&E). Table 1-1 sets forth electric energy production and generating capacity data for California.

Gas. Table 1-2 sets forth gas sales and price data for California and compares them to the other FSED states. Because of its larger population, California leads all other FSED states in residential and commercial gas sales, however, Texas leads in industrial gas sales because so much of their gas production is sold to other states. California is a net gas importer.

Table 1-1. Summary of electric energy data for the full-scale engineering development states.

STATE	ELECTRIC ENERGY PRODUCTION 1975 (GWh)[1]	ELECTRIC ENERGY GENERATING CAPACITY 1975 (MW)[2]	ELECTRIC PRODUCTION AS A PERCENT OF 1975 GENERATING CAPACITY	PERCENT OF ELECTRIC SALES BY CLASS OF SERVICE, 1974 (GWh)		
				RESIDENTIAL	COMMERCIAL	INDUSTRIAL
California	127,161	33,922	42.8	32.9	32.5	34.6
Colorado	16,644	3,707	51.3	37.3	38.7	24.0
Massachusetts	31,275	9,854	36.2	39.4	33.6	27.0
New York/New Jersey/ Connecticut	109,521	29,500	42.4	32.3	29.2	29.9
Texas	163,167	43,713	42.6	35.3	22.8	41.9
Utah	7,371	1,471	57.2	36.8	30.9	32.4
Washington	94,092	17,170	62.6	33.7	14.6	51.7

[1]Gigawatt hours (kWh x 10^6)

[2]Megawatts (kW x 10^3)

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Source: U.S. Department of Commerce, 1976.

Table 1-2. Summary of gas utility and mineral production data for full-scale engineering development states.

STATE	GAS SALES 1975 VOLUME (btu x 10^{12})				COAL AND LIGNITE PRODUCTION, 1974 (tons x 10^3) (metric tons x 10^3)	CRUDE OIL PRODUCTION, 1974 (bbl x 10^6) (m^3 x 10^6)
	RESIDENTIAL	COMMERCIAL	INDUSTRIAL[1]	$ per btu x 10^6		
California	668	238	648	1.26	—	322 (51)
Colorado	90	66	112	0.90	6,896 (6,255)	38 (6)
Massachusetts	84	37	22	2.91	—	—
New York/New Jersey/ Connecticut	344	113	106	2.14	—	1 (0.16)
Texas	246	124	1,387	1.10	7,684 (6,969)	1,222 (194)
Utah	50	17	53	0.85	5,858 (5,313)	42 (6.7)
Washington	37	35	92	1.55	3,913 (3,549)	—

[1]Covers natural, manufactured, mixed, and liquid petroleum gas.

372T-2035-2

Sources: U.S. Department of Commerce, 1976; U.S. Department of Interior, 1976.

Coal and Crude Oil. California continues to be a major producer of crude oil; about one-third of the amount produced in Texas. Fuel oil is used in California exclusively for electric generation and comprises almost half of the energy use in California. No coal is produced, and very little coal is used in California. Consumption of gasoline for transportation was 10,237 million gal. (38.8 million m^3) in 1975; diesel fuel consumption was 779.3 million gal. (3.0 million m^3). Despite increasing gasoline prices, consumption continues to rise as oil imports increase.

Water. California's water problems range from "too much" (cyclical flooding) in the north to "too little" (nearly perennial drought) in the south. Southern California required nearly 2,000,000 acre-ft (2.4×10^9 m^3) of water in 1960, and the need has grown at the rate of about 5 percent per year so that now the need is well over 4,500,000 acre ft (5.5×10^9 m^3) per year.

Since the 1920s, the Owens Valley canal has brought water to southern California from the eastern slopes of the High Sierras. During the 1930s, the Colorado River Aqueduct was added to the supply system, and during the 1960s and 1970s, the great California Water Project was constructed to bring water from the Feather River in northern California. This northern California water is of good quality. Los Angeles Basin groundwater has 650 ppm of dissolved solids and a hardness of nearly 400. Colorado River water is not much better in that respect but with a much higher sulfate content (Hunt, 1974).

Although surface supplies were small in the San Joaquin Valley until after World War II, huge supplies of groundwater were available and kept stable by west-flowing Sierran rivers. Now, however, water tables have dropped more than 100 ft (30.5 m) in some places, and the importation of northern California water via the Central Valley Project has become necessary for irrigation of that vast farming area. As the water table lowered, subsidence has taken place and soils have become more compact and less able to hold surface waters and prevent running off (Hunt, 1974).

Likewise, Santa Clara Valley groundwater withdrawals increased four fold between 1920 and 1960, resulting in a 250 ft. (76.2 m) drop in the water table. The ground in San Jose subsided as much as 8 ft. (2.4 m) by 1967, and the resulting compaction caused a reduction of the underground storage capacity of 500,000 acre-ft. (6.1×10^8 m^3). Land at the south end of San Francisco Bay subsided 4 ft. (1.2 m) and the Bay itself had to be diked to prevent flooding of bayshore land.

Groundwater is of particular importance in Alameda and Santa Clara Counties, whereas in Marin County surface water accounted for 74 percent of the 1975 supply. Water from the Delta Region is used primarily in east and south Bay counties. Forty-three percent of the water used in the Sacramento region is from the Sierras via the Hetch-Hetchy and Mokelumme Aqueducts (ABAG, 1977a).

In 1972, total water requirements in California was 37,388,000 acre-ft (4.6×10^{10} m^3) divided between requirements for irrigation, 84.8 percent; urban and suburban, 13.5 percent; and fish, wildlife and recreation, 1.8 percent (California Statistical Abstract, 1977). Table 1-3 sets forth per capita and water withdrawal data for each of the FSD states. Because of its large population and agri-business, California ranks first in withdrawals and consumption.

Air Quality. Air quality in California has a broad range of values (U.S. Environmental Protection Agency, 1977). Large portions of the state are relatively remote from dense urban populations and have good to excellent air quality. In rural areas, forest and brush fires or fugitive dust from farming activities occasionally affect air quality adversely. In the southwest desert area, dust and sand storms also cause pollution and visibility restrictions. In the areas subject to increasing population, however, a long-term trend of decreasing visibility has been identified. Locations that had 70- to 80-mi (112- to 128-km) visibilities 20 years ago ago are now experiencing many days with visibilities of 40 to 50 mi (64 to 80 km) or less. The major causes seem to be increases in rural populations and the general increase in automobile traffic, although transport of pollutants from urban centers has been identified as a contributor to visibility reductions and other pollutant increases in recent years.

Table 1-3. Summary of water withdrawn[1] per day in full-scale engineering development states, 1970.

STATE	WATER WITHDRAWN						FRESH WATER CONSUMED[3]	
	PER CAPITA[2]		TOTAL		SURFACE			
	Gallons	m^3	acre-ft	$10^6 \times m^3$	acre-ft	$10^6 \times m^3$	acre-ft	$10^6 \times m^3$
California	2,400	9.1	147,297	181.6	88,992	109.8	67,551	83.3
Colorado	6,000	22.7	39,893	49.2	33,756	41.6	20,867	25.7
Massachusetts	740	2.8	12,888	15.9	11,968	14.8	430	0.5
NY/NJ/CT	970	3.7	55,236	68.1	52,167	64.3	2,025	2.5
Texas	2,400	9.1	82,854	102.2	55,236	68.1	29.459	36.3
Utah	4,000	15.1	12,888	15.9	10,740	13.2	6,751	8.3
Washington	2,100	7.9	22,094	27.3	19,333	23.8	7,672	9.5

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[1]Withdrawal signifies water physically withdrawn from a source.

[2]Based on population as of 1 April 1970.

[3]Evaporated, transpired, or incorporated into products; excludes irrigation conveyance losses by evapotranspiration.

Source: U.S. Department of Commerce, 1976.

Some metropolitan areas within California have air pollution problems. Those within the San Francisco Bay air shed and the Los Angeles Basin are well known. The smog, generated in both regions as the result of photochemical reactions involving automobile exhaust emissions and other sources of hydrocarbons and nitrogen oxides, affects visibility and causes health problems of varying severity. Control measures for mobile and stationary sources implemented within the past decade have resulted in improvements, in spite of increases in traffic volumes and population levels.

Presently, vigorous measures are being undertaken at state and national levels to continue the improvement in air quality with enforcement of existing source emissions criteria, new source review procedures, and continuing technology to provide better control methods for all pollutants.

Economic Specialization. The industry with the most export employment in the major metropolitan area is General Government with approximately 121,000 export-oriented jobs; Transportation Equipment has export employment of almost 97,000; Electrical and Electronic Equipment (57,000); and Ordnance and Accessories (47,000) (EIFS, 1978). Other dominant industries include Business Services, Motion Pictures, Communications, Machinery except Electrical, Fabricated Metal Products, and Hotel and Other Lodging Places. The aerospace industry itself and most of the support industries are well developed in the region. Contracts awarded in this area will require very little, if any second tier contracting outside the region.

Income and Earnings. Total earnings in 1975 equaled $65.0 billion (1967 dollars) (BEA, 1977). Real per capita income has consistently exceeded the national level. In 1975, real per capita income was $4,092 in spite of a slight decline during 1974-1975. The state experienced a 1967-1975 average annual growth rate of 1.8 percent. To reach BEA projections for 1980, a 4.9 percent annual rate would be required for 1975-1980, and this seems unlikely.

Employment. Total employment in 1975 was about 9.3 million people (BEA, 1977). Together, Wholesale and Retail Trade were most important industrial divisions, with over 19 percent of the total work force. Also important were Services and Manufacturing, with 19 and 17 percent of the state's total employment respectively.

Unemployment. California has a large idle supply of labor. In 1977, the state's unemployment rate was 7.7 percent of the civilian labor force (California Development Department, 1978). During the 1960s, California's unemployment rate fell as low as 1969's 4.4 percent. Unemployment reached its peak of 9.2 percent in 1976 with substantial recovery in the past year.

Colorado (1.2.2.2)

Energy. Generally, it can be stated that Colorado is presently energy rich with some slight deficits expected in the northeast part of the state in 1985 but with surpluses expected in the rest of the state (Oak Ridge National Laboratories, 1977).

Electric. While United States consumption of electric power in 1974 was 884 megawatts per million persons, in Colorado that figure was only 656 megawatts. About 20 percent of Colorado's electric power generating capacity is hydro, compared to 13 percent for the United States as a whole. Electric production in 1975 was 51.3 percent of electric generating capacity (U.S. Department of Commerce, 1976).

Most electricity in the Colorado region is supplied by Public Services of Colorado. The city of Denver generates about two-thirds of its own power (Denver Chamber of Commerce, 1977a). Table 1-1 sets forth other data on Colorado electrical energy production and consumption.

Gas. Public Services of Colorado also is the principal supplier of natural gas in the Denver area. Supplies of natural gas are presently abundant in Colorado, as indicated by its relatively low cost; however, importation is expected to be necessary in the future (Denver Chamber of Commerce, 1977a).

Coal and Crude Oil. Colorado is a leading producer of coal among the full-scale engineering development states, producing 6,896,000 tons (6,250,000 metric tons) in 1974. Much of this production comes from the Four Corners region in southwestern Colorado. Colorado is also a source of petroleum production and on a per capita basis, exceeds the national average by nearly three fold (U.S. Department of the Interior,1976).

Water. Generally, it can be stated that Colorado presently has ample and good quality water. Colorado, like other Rocky Mountain states, collects and stores water carried by its rivers. In 1963, the United States Supreme Court decided that allotments of Colorado's river water should go to seven Rocky Mountain and southwestern states. Colorado, Wyoming, Utah, and New Mexico were allotted 50 percent of the assumed 15 million acre-ft (18.5×10^9 m^3) per year runoff. Reservoirs along the foot of the Rockies retain water for hydro power and irrigation.

Water quality is generally excellent with less than 100 ppm of dissolved solids. Local problem areas exist.

Air Quality. On a statewide basis, air quality is quite good in Colorado, one of the better areas in the country (U.S. Environmental Protection Agency, 1977). In urban areas, however, the problem of pollution is severe on occasion. For example, in 1975 Denver had one of the highest hourly carbon monoxide values in the country. Concurrently, some of the most dust-free air in the nation also occurred within the state.

Data on pollutant levels are limited primarily to populated arid surrounding areas and do not represent the larger rural areas well. Nevertheless, significant periods are apparent after storms move through the state when pollutant levels decline to values well below air quality standards and remain there for a few days or a week, even in the population centers.

As Colorado becomes more industrialized, possibly with increased mining activities to recover oil shale deposits available in some areas of the state, air quality may deteriorate from present levels. Specific control measures and operating requirements to meet strict air quality standards will prevent a runaway situations from developing, but some concern must be directed toward increased pollutant levels. Due to the location of the Rocky Mountains, the state is liable to experience poor dispersion conditions and high pollution potential at times. Particularly poor conditions may develop in the winter with occasional stagnant weather systems affecting the state for periods of a week or more. Under these conditions, air quality standards have been exceeded in the metropolitan areas in the past and probably in outlying areas with large pollutant-emission sources.

Economic Specialization. In Colorado's largest metropolitan area, the major source of employment is General Government with more than 41,000 export-oriented jobs; Wholesale Trade trails behind with about 10,000 jobs and Construction Industry with about 8,000 jobs (EIFS, 1978). Other dominant industries include Food and Kindred Products, Hotels and Other Lodging Places, Electrical and Electronic Machinery, Eathing and Drinking Places, Communications, Machinery except Electrical, and Business Services. The aerospace industry itself and a major support industry—Aircraft Equipment—are well developed in the region. Other support industries, however, are not well developed and contracts awarded in this area will require substantial second tier contracting outside the region.

Income and Earnings. Total earnings in 1975 equaled $7.4 billion (1967 dollars) (BEA, 1977). Real per capita income has generally exceeded the national level. In 1975, real per capita income was $3,721 in spite of a slight decline during 1973-1975. The state experienced a 1965-1975 average annual growth rate of 2.8 percent. The BEA projections for 1980

expect an annual growth rate of 4.6 percent for the 1975-1980 period; given the historic trend, this seems unlikely.

Employment. Total employment in 1975 was about 1.2 million persons (BEA, 1977). Together, Wholesale and Retail Trade Divisions were most important, with over 20 percent of the total work force. Also important were Services, 17 percent, and Manufacturing, which employed almost 12 percent of the work force.

Unemployment. In 1977, the state's rate of unemployment was about 6.4 percent of its civilian labor force (U.S. Bureau of Labor Statistics, 1977a, 1977b). During the 1960s, Colorado's unemployment rate fell as low as 3.0 percent, essentially reaching full employment. Unemployment reached 6.4 percent in 1977; available data do not indicate if it has since peaked, and begun falling. Thus, the state's unemployment picture has been worsening in the past few years.

Massachusetts (1.2.2.3)

Energy. It can be stated that energy supplies are generally adequate; however, Oak Ridge National Laboratories predict a slight electric generating capacity deficit by 1985.

Electric. In 1974, 19 percent of the energy produced in Massachusetts was hydro-generated compared to 15 percent for the U.S. as a whole. Hydro-electric power generating capacity was 17 percent of the total capacity; this compares to 13 percent in the United States. Massachusetts per million population consumption of electricity in 1974 was 827 megawatts compared to the U.S. average of 884 megawatts. Electric production was 36.2 percent of generating capacity in 1975 (U.S. Department of Commerce, 1976).

The Boston area receives its power primarily from the Massachusetts Electric Company, while outlying communities are supplied by Boston Edison (Boston Chamber of Commerce, 1977). Table 1-1 shows other electrical energy data for the state of Massachusetts.

Gas. Primary gas suppliers in Massachusetts include the Laurence Gas Company and the Lowell Gas Company. Available forecasts indicate neither gas nor fuel oil shortages are expected in Massachusetts (Boston Chamber of Commerce, 1977). Table 1-2 shows gas sales data for Massachusetts.

Coal and Crude Oil. None is produced in Massachusetts.

Water. Generally, it can be stated that water supply will not be a problem in Massachusetts for at least 20 years. The problems relate to spring flooding and pollution. Surface runoff averages 10 inches (254 mm) of precipitation per year. Most cities use surface water because it is plentiful. The supplies average less than 100 ppm of dissolved solids.

Air Quality. Although there are areas within Massachusetts with air quality problems, such problems occur infrequently and most air quality monitoring results in average values that do not exceed published standards. Suspended particulate data from the 1977 EPA nationwide summary showed a maximum value of 170 micrograms per cubic meter for all observations taken within the state. This is a low value of suspended particulates relative to those observed in most states.

As in most urban areas, smog or at least photochemical oxidants and ozone can be found in the major metropolitan areas of the state. Maximum values are just above the national standard for 1 hour sampling times, but 90 percent of the observations are well below it. Transport of ozone over quite long distances has been documented along the eastern seaboard at levels that indicate some of the Massachusetts data may be reflecting transport of ozone into the state from other areas. Hydrocarbon levels are not monitored within Massachusetts. Some hydrocarbons produced by the mixed forest cover, particularly in the central and northern parts of the state, are unreacted photochemically until nitrogen oxides from automobiles or power plants build past a certain level. Then some ozone is generated and may cause potentially tree-damaging concentrations to occur in some areas.

Carbon monoxide and sulfur dioxide are monitored in population centers and do not appear to be exceeding public safety standards there, so there is little expectation that higher levels would occur elsewhere in the state. The overall evaluation for air quality within Massachusetts is good based on the data presently at hand.

Economic Specialization. In Massachusetts' largest metropolitan area, the industry with the most export employment is General Government, with approximately 60,000 export-oriented jobs; Health Services has export employment of 39,000; Educational Services of 35,000; and Electrical and Electronic Machinery over 30,000 jobs (EIFS, 1978). Other dominant industries include Machinery except Electrical, Professional and Scientific Instruments, Insurance, Leather and Leather Products, Wholesale Trade, and Business Services.

Support for the aerospace industry and the industry itself are poorly developed in the region. Contracts awarded in this area will require substantial second tier contracting outside the region.

Income and Earnings. Total earnings in 1975 equaled $76.0 billion (1967 dollars) (BEA, 1977). Per capita income has consistently exceeded the national level. In 1975, real per capita income was almost $3,763 in spite of a slight decline during 1973-1975. The state experienced a 1965-1975 average annual growth rate of 1.7 percent. To reach BEA projections for 1980, a 6.7 percent annual rate would be required for 1975-1980 and this seems unlikely.

Employment. Total employment in 1975 was about 2.5 million people (BEA, 1977). Manufacturing was the most important industrial division with about 23 percent of the total work force. Also important were Wholesale and Retail Trade (20 percent), and Services (21 percent).

Unemployment. Massachusetts has a large idle supply of labor. In 1977, the state's unemployment was 6.7 percent of the civilian labor force (U.S. Bureau of Labor Statistics, 1977a, 1977b). During the 1960s, Massachusetts unemployment rate fell as low as 3.9 percent, very near full employment. Severe cutbacks in construction, federal government employment and manufacturing, aggrevated by increased oil prices, led to a 12.5 percent unemployment peak in 1975 with substantial recovery in the past two years.

New York/New Jersey/Connecticut (1.2.2.4)

Energy. It can be generally said that the region has problems with adequate energy supplies with severe shortages predicted in the New York City area and surpluses indicated in upper New York State (Oak Ridge National Laboratories, 1977).

Electricity. In 1975, 26 percent of the electricity produced in the region was hydro-generated compared to the U.S. average of 15 percent. The hydro-generating capacity was 17 percent of the total compared to the U.S. average of 13 percent. The region's per million population electric consumption in 1974 was 590 megawatts compared to the U.S. average of 884 megawatts. Electric production was 42.4 percent of capacity in 1975 (U.S. Department of Commerce, 1976).

The New York City area is supplied electricity by the Consolidated Edison Company and has suffered severe power shortages including blackouts in recent years. Upper New York State receives hydro-generated electricity from Niagara Falls — a much more reliable source. Table 1-1 shows data on electric generation in the New York/New Jersey/Connecticut region.

Gas. Gas and fuel oil supplies are adequate in the region, but are experiencing the same price increases as the rest of the nation. Table 1-2 shows gas sales data for the region, it will be noted that the cost of gas to the people in the region was nearly twice as high as to Californians in 1975.

Coal and Crude Oil. Little or none is produced in the region.

Water. It can be generally said that the region has adequate and good quality water, a situation that should continue into the future. Water supplies in the southern part of the region are rather stable with a relatively low flooding potential and only short duration droughts. Annual runoff is 20 to 25 in. (508-635 mm). Dissolved solids in groundwater averages only 60 ppm on Long Island but up to 350 ppm farther north.

Upper New York State has an annual runoff of 15 to 20 inches (381-508 mm). Fifty percent of this occurs in the spring making the flooding potential relatively high. Overall the quality of surface water is good but with dissolved solids ranging from 120 to 350 ppm. Groundwater is generally softer.

Air Quality. Within the State of New York there are urban and industrial areas that have higher maximum pollution levels than New York City does. Hydrocarbon concentration levels and measured ozone concentrations were higher in some upstate and western portions of the state than they were in New York City in 1975. The city itself also showed relatively low carbon monoxide maxima compared to most of the surrounding areas. According to EPA data, a maximum particulate concentration of only 147 $\mu g/m^3$ was recorded in New York City in 1975.

Airborn particulate levels throughout the state are not in general higher than standards, but peaks well above the standards occur about 17 percent of the time in the Buffalo area. Other pollutants such as sulfur dioxide and nitrogen oxides also seem to have very high occasional peak concentrations; sulfur dioxide tends generally to be worse than the nitrogen oxides on a one-hour sample basis. Nonurban values of most pollutants are lower than the urban ones but transport distances from large urban centers are not great in the northeastern part of the country and wind patterns carry relatively high concentrations throughout the state.

Economic Specialization. In the region's largest metropolitan area, the industry with the most export employment is Apparel and Other Textiles with about 172,000 export-oriented jobs, followed by Business Services (146,000 jobs), Banking (89,000 jobs) and Printing, Publishing, and Allied Industries (77,000 jobs) (EIFS, 1978). Other dominant industries include Security and Commodity Brokers and Allied Services; General Government; Real Estate; Local and Suburban Transit; Electrical and Electronic Machinery; and Miscellaneous Manufacturing Industries. Although the Guided Missile Industry itself is poorly developed in the region, several support industries are well developed. Contracts awarded in this area will require relatively fewer second tier contractors outside the region.

Income and Earnings. Total earnings in 1975 amounted to $86.2 billion (1967 dollars) (BEA, 1977). Real per capita income has shown growth trends very similar to those for the nation, and has always exceeded it. In 1975, real per capita income was $4,075 in spite of some decline during the 1973-1975 period. New York experienced a 1965-1975 average annual growth rate of 1.4 percent. To reach BEA projections for 1980, a 6.9 percent annual rate would be required for 1975-1980; given historic rates, this seems unlikely.

Employment. Total employment in 1975 was more than 12 million people (BEA, 1977). Manufacturing was the most important industrial division with about 20 percent of the total work force. Also important were Services (19 percent), and Wholesale and Retail Trade, which together comprised almost 19 percent of state employment.

Unemployment. This region has a large idle supply of labor. In 1977, their unemployment rate was 8.4 percent of the civilian labor force (U.S. Bureau of Labor Statistics, 1977a, 1977b). During the 1960s, their unemployment rate fell as low as 1969's 4.9 percent. Unemployment reached its peak of 10.3 percent in 1975-1976 with substantial recovery in 1977.

Texas (1.2.2.5)

Energy. It can be said that Texas is an energy rich state. It leads the nation in petroleum production, and all of the FSED states in lignite coal production.

Electricity. In 1975 only one percent of the electricity produced in Texas was hydro-generated, and the hydro-generated capacity is likewise only one percent; this compares to the U.S. averages of 15 percent

and 13 percent respectively. The 1974 per million population consumption of electricity in Texas was 1,148 megawatts compared to the U.S. average of 884 megawatts. Electric production was 42.6 percent of generating capacity in 1975 (U.S. Department of Commerce, 1976). Table 1-1 sets forth additional data on electricity.

The availability of fuel oil in Texas makes possible the relative abundance of electric energy in this state. Except for the most westerly and southerly portions of the state, generating surpluses are projected through 1985 in Texas (Oak Ridge National Laboratory, 1977).

Gas. Table 1-2 indicates gas sales data for Texas and other FSED states. It will be noted that Texas sells over 75 percent of its gas production to industrial users, compared to less than 50 percent by all other FSED states other than Washington. Much of this is for export of electrical energy and export as natural gas.

Coal and Crude Oil. As might be expected, Texas is by far the largest producer of lignite and crude oil among the FSED states. Table 1-2 sets forth these figures for Texas and other FSED states.

Water. It can be said that generally, Texas has adequate water to support the state through the end of the century with adequate to good quality. In Texas, the content of dissolved solids in surface water is about the same as groundwater. In some parts of Texas, Houston for example, the water contains sodium and the hardness is only moderate even though the dissolved solids are considerable.

The lush agricultural high plains of the Texas panhandle are irrigated from the huge Ogalalla Aquifer. This basin is not being replenished nearly as fast as it is being depleted and it is expected that by the year 2020 it will be nearly completely depleted (Hunt, 1976).

Air Quality. Texas in general has quite good air quality. The only problem for a large portion of the state is suspended particulates or dust (U.S. Environmental Protection Agency, 1977). Wind conditions within the state are often strong enough to suspend large quantities of dust and transport them hundreds of miles. Dust also causes visibility problems, and in an area on the Texas High Plains in the panhandle, visibility is reduced by dust more often than anywhere else in the country.

Emissions from oil tank farms in the southeast Texas area are the source of high concentrations of hydrocarbons in Houston and along the coast in its vicinity. Petroleum processing in this corner of the state also contributes significantly to air quality degradation. Ozone levels are exceeded in this area as well as in other urban centers across the

state. This occurs only occasionally, however, and for the most part (over 90 percent of the time) average ozone levels in Texas range from about one quarter to about four-tenths of the national standards.

Carbon monoxide concentration maxima are generally about half of the required standard or less and pose little problem within the state. Sulfur dioxide from petroleum processing is more of a problem, as both the maximum value and the frequency with which the standard is exceeded are high. Nitrogen oxides concentrations are relatively low with most of the values below the national standard but an occasional maximum excursion up to four times the standard concentration has occurred in the past.

For the nonurban areas of the state some transport of pollutants occurs from the source regions, but little evidence exists that air quality levels are a problem.

Economic Specialization. In Texas' largest metropolitan area, the industry with the most export employment is General Government with about 32,000 export-oriented jobs followed closely by Transportation Equipment with 31,000, and Wholesale Trade with 30,000 jobs (EIFS, 1978), Other dominant industries include Electrical and Electronic Machinery, Insurance, General Merchandise Stores, Construction, Machinery except Electrical, Apparel and Other Textiles, and Hotels and Other Lodging Places. Support for the aerospace industry and the industry itself are well-developed in the region. This has been particularly true with Aircraft, and Aircraft Equipment Industries. Contracts awarded in this region will require relatively fewer second tier contractors outside the region.

Income and Earnings. Total earnings in 1975 equaled $32.8 billion (1967 dollars) (BEA, 1977). Real per capita income has been consistently below the national level. In 1975, real per capita income was $3,495 in spite of a slight decline in the 1973-1975 period. The state experienced in 1965-1975 an average annual growth rate of 3.2 percent. To reach BEA projections for 1980, a 4.2 percent annual rate would be required for 1975-1980. Given historic income trends, this seems only slightly optimistic.

Employment. Total employment in 1975 was about 5.5 million people (BEA, 1977). Wholesale and Retail Trade were most important industrial divisions, with about 20 percent of the total work force. Also important were Services (16 percent), and Manufacturing (15 percent).

Unemployment. Texas has consistently experienced lower unemployment rates than the nation. In 1977, the state's unemployment rate was 5.1 percent of the civilian labor force (U.S. Bureau of Labor Statistics, 1977a, 1977b). During the 1960s, its unemployment fell as low as 1967's 2.8 percent rate. Unemployment reached its peak of 6.1 percent in 1975, with substantial recovery in the past two years.

Utah (1.2.2.6)

Energy. Because of its huge, newly utilized coal reserves, especially in the Four Corners area, Utah is an energy rich state.

Electricity. The 1975 hydroelectric production and generating capacity in Utah in 1975 was very similar to the rest of the nation in that the share of total electricity production and generating capacity was 15 percent and 13 percent respectively. The state's electrical consumption per million population was 667 megawatts compared to the national average of 884 megawatts. The 1975 production of electricity in Utah was about 57 percent of generating capacity (U.S. Department of Commerce, 1976). Table 1-1 shows other electric energy data for Utah.

Gas. The cost of natural gas in Utah is the lowest of any of the FSED states (see Table 1-2). Utah is nevertheless a natural gas importer.

Coal and Crude Oil. About 95,000 barrels (1.5 x 10^9 m^3) of oil a day are produced in Utah. The state is second in coal production among the FSED states (see Table 1-2).

Water. The Colorado and Virgin rivers flow through Utah. The state is the second driest state in the nation. Salt Lake City averages only 13 in. (330 mm) of rain per year. Surface runoff averages 2 in. (51 mm) per year with the peak in March. Prevalent chemicals found in the water are sodium, potassium, sulfates, and chlorides. The dissolved mineral content is high: 1,800 ppm. Approximately 81,000 acre-feet (100 x 10^6 m^3) of water are extracted annually from the state's aquifers and combined with the Colorado River allotment which is part of the Supreme Court's Colorado River Compact (Hunt, 1976).

Air Quality. In spite of its size and generally sparse population, Utah has some of the poorest air quality in the nation (U.S. Environmental Protection Agency, 1977). Maximum values for all pollutants except ozone are among the highest recorded anywhere in the nation, and in 1975 suspended particulates concentrations and sulfur dioxide concentrations exceeded those for California and New York. These large maximum values occur primarily in the Salt Lake City area, which is dominated by stagnant air mass conditions. Under these conditions mixing may occur through the valley in which most of the industrial activity of Utah is located, but very little transport outside this area occurs. As the stagnant conditions generally last for several days, pollutant levels build up to peak values that are not relieved until the air mass moves on or is disturbed by an advancing storm. Summer conditions tend to be worse than in the winter as circulation patterns are less well defined and there are fewer changes favoring the movement of a well-entrenched system. Oxidant

levels under these conditions tend to escalate, and in the 1975 data include values up to 290 $\mu g/m^3$, well above the published primary standard of 160 $\mu g/m^3$.

Outside of the major urban area the state of Utah enjoys good air quality. Protection of wilderness areas and the maintenance of air quality at or below a specified low pollution level has been mandated by the EPA for several designated areas within the state. Regardless of weather conditions or pollution potential, these areas are to be preserved as national resources. The development of emissions sources within their bounds or the potential transport there of pollution from external sources requires stringent emissions controls in order to meet the air quality criteria.

Economic Specialization. In Utah's largest metropolitan area, the industry with the most export employment is General Government, except Finance with approximately 36,000 export employment jobs; Wholesale Trade has export employment of slightly more than 6,000 jobs; and Membership Organizations, 4,000 jobs (EIFS, 1978). The region has a relatively small economic base; many other industries have 2,000 to 3,000 export employment jobs, including Metal Mining; Transportation Equipment; Electrical/Electronic Equipment; and Hotels and Other Lodging Places. Support for the aerospace industry and the industry itself are poorly developed in the region. Contracts awarded in this region will require substantial secondary support contracting outside the region.

Income and Earnings. Total 1975 earnings equalled \$2.9 billion (BEA, 1977). Real per capita income has consistently been below that for the nation. In 1975, real per capita income was about \$3,343. Utah experienced rapid growth; its 1965-75 annual per capita growth was 2.8 percent. To reach BEA projections for 1980, a 3.7 percent annual rate will be required for 1975-80; given historic growth, this seems achievable.

Employment. Total employment for 1975 was about 497,000 persons (BEA, 1977). Wholesale and Retail Trade were the two most important industrial divisions; together, they accounted for 21 percent of total state employment. Also important were Services (14 percent), and Manufacturing (13 percent).

Unemployment. In 1977, Utah had only an unemployment rate of 5.0 percent of its total civilian labor force (U.S. Bureau of Labor Statistics, 1977a, 1977b). Over the 1965-1977 period, the state experienced low stable unemployment, generally keeping within a 4.5 to 5.5 percent band. This resulted from a stable economy and population structure; few dynamic alterations took place. Peak unemployment occurred with 1975's 7.5 percent, with substantial recovery in the past two years.

Washington (1.2.2.7)

Energy. The state of Washington can be counted as energy rich with its huge hydro-energy potential and large coal reserves.

Electricity. Because of the great generating facilities along the Columbia River, 89 percent of the electricity produced in Washington in 1975 was hydro, and the state's hydro-generating capacity was 84 percent total generating capacity. These figures compare to 15 percent and 13 percent respectively for the United States as a whole. The per million population consumption of electrical energy was 1,861 megawatts compared to the U.S. figure of 884 megawatts. The state of Washington is a large exporter of electrical power (U.S. Department of Commerce, 1976).

Gas. Except for interruptable industrial customers, Washington has been able to meet the demand for natural gas service for the last several years. The cost of gas in Washington is relatively high (see Table 1-2).

Coal and Crude Oil. There is no crude oil production in Washington, however, large coal reserves exist in eastern Washington (Hunt, 1976).

Water. The State of Washington, despite the presence of the semiarid Columbia-Snake River plateau has abundant water supplies, both surface and groundwater. The Columbia River, even in eastern Washington, has a greater discharge than the Missouri River. Where it enters the Cascade Range the discharge is equal to nearly half the Mississippi River at Memphis. Its principal tributary, the Snake River has a discharge 3 or 4 times that of the Colorado River (Hunt, 1976).

Dissolved solids in groundwater consist primarily of calcium and magnesium bicarbonate. Surface waters are low in dissolved minerals and suspended solids, and are moderately soft with mineral concentrations being less than 100 ppm.

Air Quality. Washington State receives some of the cleanest air in the nation, directly off the Pacific Ocean, as reflected by the low levels of ozone measured in its urban areas. The low ozone levels also result from the reduced number of days with sunshine, which puts a damper on the photochemical processes necessary to ozone formation. Suspended particulates show surprisingly large concentrations for a coastal state because the coastal mountains modify the local air flow patterns and inhibit dilution of the contributions from urban and industrial sites on the coast.

The long downwind urban plumes of pollutant detected in other segments of the country do not cross the mountains, so the particulate pollutants are effectively concentrated in the coastal urban areas. Seattle had 1975 EPA-recorded maximum suspended particulate concentrations of 308 $\mu g/m^3$. Carbon monoxide, sulfur dioxide, and nitrogen oxide concentrations show the same enhanced maxima. Urban areas farther inland tend to be in steep-walled valleys where pollutants may be well mixed by local circulations in a limited air volume but have little chance of being mixed into regional air masses.

Hydrocarbon levels are not monitored in the state and consequently nitrogen oxide concentrations are the only clue to the variations in ozone level. Ozone levels seem to match nitrogen oxide concentration trends, indicating that hydrocarbons are present at least at a level conducive to photochemistry. It is not known whether the primary source is vehicular or natural emissions within the extensive state forest growth. Current urban ozone levels suggest that nonurban concentrations might be large enough to cause damage to trees similar to that observed in other parts of the country. Additional vehicles, or other nitrogen oxide sources introduced to the area could increase these ozone levels and create a significant air quality problem.

Economic Specialization. In Washington's largest metropolitan area, the industry with the greatest export employment is Transportation Equipment, with approximately 37,000 export-oriented jobs (EIFS, 1978). General Government except Finance had export employment of slightly over 20,000 persons; Wholesale Trade, 9,000. Other dominant industries include Justice, Public Order and Safety; Health Services; General Merchandise Stores; and Lumber and Wood Products. Support for the aerospace industry is well represented in the region, despite the fact that the missile industry itself does not appear. Aircraft and Aircraft Equipment industries, which provide almost 45 percent of the total inputs to the Guided Missile industry, were dominant export-oriented industries. Contracts awarded in this area will not require substantial secondary support contracts from outside the region.

Income and Earnings. Total earnings for 1975 were $10.3 billion (BEA, 1977). Real per capita income has consistently exceeded that for the nation. In 1975, real per capita income was about $3,898. The region experienced a 1965-75 average annual growth rate of 2.2 percent. However, it has exhibited cyclical variability, ranging from a 7.9 percent annual rate in 1966, to 1970's -3.9 percent. To reach BEA projections for 1980, a 4.7 percent annual rate would be required for 1975-80; given the historic trend, this seems unlikely.

Employment. Total 1975 employment was about 1.5 million persons (BEA, 1977). Together, Wholesale and Retail Trade divisions were most important with about 19 percent of the total. Also important were Manufacturing (16 percent), and Services (16 percent).

Unemployment. Washington has experienced highly variable rates of unemployment. In 1977, its rate of unemployment stood at 4.1 percent of the civilian labor force (U.S. Bureau of Labor Statistics, 1977a, 1977b). During the late 1960s, unemployment rates fell as low as 1966's 4.1 percent; the state had almost achieved full labor employment. However, by the early 1970s, demand for the state's products fell off, resulting in severe unemployment; rates soared to as high as 1971's 10.1 percent. The state began a modest recovery in 1973, but was halted due to widespread recession. Only over the past two years has the state begun to recover.

Existing Environment at Selected Test Sites (1.2.3)

This section presents a brief environmental narrative of the facilities which will be used to test various components of the MX. The Arnold Engineering and Development Center at Arnold AFS in Tennessee will be responsible for missile scale model subsonic/transonic wind tunnel tests, missile supersonic wind tunnel tests, guidance and control/instrumentation flight safety systems integrated dynamic and static tests (SAMSO, 1977). The Air Force Rocket Propulsion Laboratory at Edwards AFB in California will be responsible for missile model electromagnetic pulse (EMP) tests, and full-scale missile EMP tests (SAMSO, 1977).

Figure 1-4 shows the location of the Air Force bases known to be involved in FSED. Table 1-4 sets forth comparative data on the three AFB testing centers. Edwards AFB is by far the largest base with some 300,000 acres (120,000 ha), but Kirtland near Albuquerque has the most personnel with about 9,200.

Arnold Air Force Station. Arnold AFS is the site of the billion dollar Arnold Engineering development in south central Tennessee. This 40,000 acre (16,000 ha) base contains a 3,000 acre (1,200 ha) fenced laboratory area on which test facilities stand; the 4,000 acre (1,600 ha) Woods Reservoir; a 40-family housing area; a 6,000 ft (1,929 m) airstrip; an Officers' Open Mess; a Non-Commissioned Officers' Mess; and routine recreation areas. Over 90 percent of the personnel are civilians who carry on highly technical testing of military flight components.

Arnold AFS was activated in January of 1950, and the first test facilities went into operation in 1953. Testing has progressed since that time with new facilities being added to meet changing needs (AEDC, 1977).

Arnold AFS is the site of the Arnold Engineering Development Center (AEDC), the nation's largest complex of wind tunnels, jet and rocket engine test cells, space simulation chambers, and hyper-ballistic ranges, which support the acquisition of new aerospace systems (Air Force Magazine, 1978). The AEDC Mission is to support the timely acquisition of

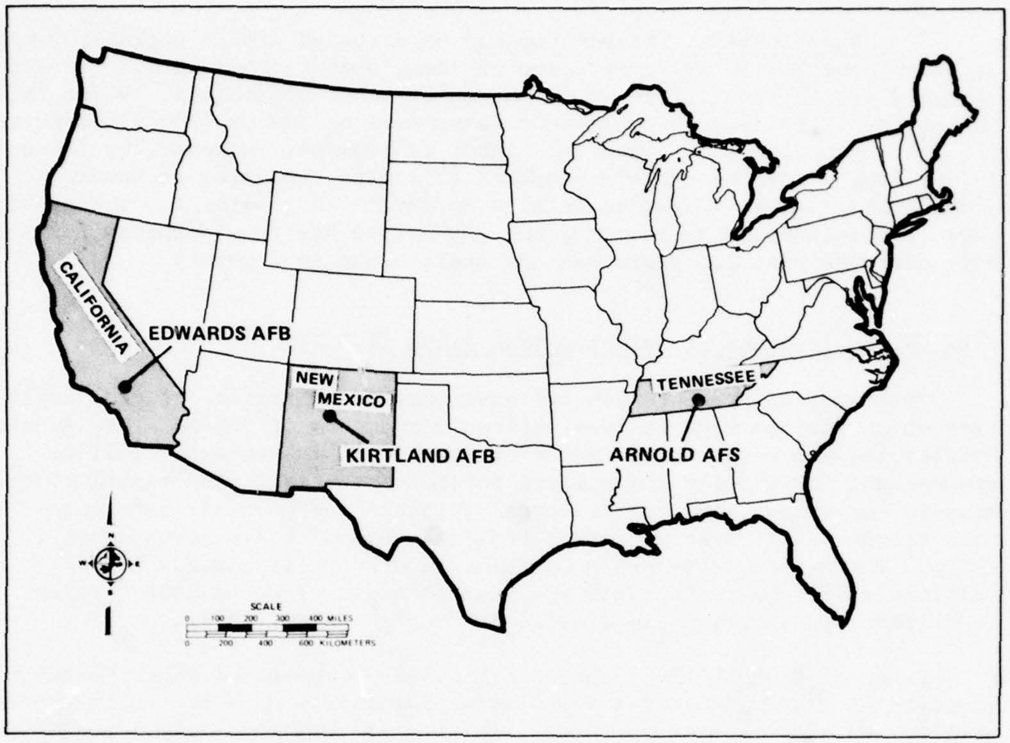


Figure 1-4. Location of full-scale engineering development testing locations.

superior aerospace systems research, development, testing, analysis and evaluation, and studies utilizing aerospace environmental testing facilities. As of February 1977, the replacement value of the center was $1,130,000,000. The operation of the center is accomplished by a civilian contractor who employs about 3,200 personnel. Military and civil service personnel number about 250 (AEDC, 1977).

Arnold AFS is located in south central Tennessee approximately midway between Nashville and Chattanooga. The area has approximately 40,000 acres (16,000 ha) extending eastward from Tullahoma. The topography of the center is level to moderately rolling, and ranges in elevation from about 900 to 1,150 ft (290 to 350 m) above sea level. The vegetation on the undeveloped portion of the reservation is characterized by moderately dense underbrush and a large number of pine trees which were originally planted to attenuate sound. About 300 acres (120 ha) have been set aside by the U.S. Department of Interior as a registered national landmark because of their special botanical interest.

Table 1-4. Comparative data on full-scale development test locations.

CHARACTERISTIC	ARNOLD	EDWARDS	KIRTLAND
Activation Date	Jan. 1950	Sept. 1933	Jan. 1941
Nearest Large Community	Tullahoma, Tennessee	Lancaster, California	Albuquerque, New Mexico
Area (acres) (hectares)	40,118 (16,047)	301,000 (120,400)	54,108 (21,643)
Altitude (ft) (m)	950-1,150 (290-350)	2,302 (606)	5,352 (1,632)
Military Personnel	100	3,814	4,584
Civilian Personnel	3,180	4,778	4,596
Total Payroll (1977 \$ x 10^6)	63.8	134.2	210.0
Officer Onbase Housing	24	486	731
NCO Onbase Housing	16	1,570	1,403
Transient/Guest Housing	0	153	58
Hospital Beds	0	25	50

Average mean temperature is 59.3° F (15° C) with extremes being -5° F to 105° F (-15 to 41° C). Average precipitation is 50.5 in. (128 cm) of rain and 4 in. (10 cm) of snow. Predominate wind direction is south to southeast with velocities of about 5 knots (2.6 m/sec) much of the time.

The Elk River forms the south boundary of Arnold AFS, while surface drainage to the north and east flow to the Duck River. The reservation includes the 4,000 acre (1,600 ha) Woods Reservoir on the Elk River. A wildlife conservation program managed by the Tennessee Wildlife Resources Agency has been established since 1954. The program has been quite successful with the stocking of deer and wild turkey, and these wildlife are now hunted to control their population. Numerous other species of mammals, birds, and reptiles also inhabit the reservation, while a wide variety of fish exist in Woods Reservoir (AEDC, 1977).

The city of Tullahoma, just west of the base had a population of 15,311 in 1970. The city of Chattanooga which lies about 80 highway miles (128 km) to the southeast, had a 1970 population of about 120,000, while Nashville, which lies about 70 highway miles (112 km) to the northwest, had a 1970 population of about 448,000 (U.S. Department of Interior, 1973).

The greatest impact on local business is wages and salaries. In constant dollars, the total personal income in Coffee County increased 354 percent between 1950 (pre-AEDC) and 1971, while per capita income increased 231 percent during the same period. (This compares to the 171 percent national average.) Retail sales increased 365 percent between 1948 and 1972 (in constant dollars).

The operations are isolated and a buffer zone is maintained between the center and nearby communities.

The electrical energy used by AEDC in FY 1975 (627 GWH) is similar in quantity to that used by a city of 100,000 population and is equal to 0.6 percent of the Tennessee Valley Authority total sales. Standby generators are tested every two weeks and produce only insignificant amounts of emissions.

Standards for most emissions into the atmosphere from test operations are established by EPA and are carefully monitored. Analysis of these emissions after scrubber processing indicate that concentrations were at a safe level and air quality standards were met. Other emissions for which standards are nonexistent include freon and ethylene glycol. Likewise, the AEDC steam plants, air heaters and air dryers are in conformance with Tennessee air quality standards and it is estimated that the impact is not significant.

Because of the large quantity of cooling water used by the technical facility and by the use of the retention reservoir for additional dilution, monitoring of the water shows that quality standards are being met. Except for periods of very heavy rainfall, the two sewage treatment plants at Arnold AFS operate within National Pollution Discharge Elimination System permit criteria. Except for a minimal migration of chrome, an assessment of the solid waste disposal systems at AEDC shows no average effect. Approximately 20 yd^3 (15 m^3) of toxic wastes are buried per year without observable affect on air quality and only the minimal migration of chrome effect on groundwater cited above.

The greatest noise impact is generated at the engine testing facility and rocket engine testing facilities. While noise ratings can be as high as 124 dBA at the testing facilities, no significant effect on the environment is experienced outside of AEDC. (AEDC, 1977).

Kirtland Air Force Base. Kirtland AFB is a 54,000 acre (21,600 ha) military reservation near Albuquerque, New Mexico. The only military aviation program at the present time is the 1550th Aircrew Training Squadron and a search and rescue unit. The principal Air Force mission

is nuclear and laser research, testing, and development. Over 9,000 personnel work at the base, most of whom live in nearby Albuquerque. No significant negative environmental effects result from the base activity.

Kirtland AFB, located on the south city limits of Albuquerque, New Mexico, was activated in January, 1941. It is named for Colonel Roy S. Kirtland, air pioneer and commandant of Langley Field, Virginia in the 1930s.

Many military and military related agencies occupy Kirtland AFB, and their primary missions on the base are to furnish contract management; nuclear and laser research, development and testing; operational test and evaluation services; advanced helicopter training; and search and rescue. In addition to the approximately 9,200 military and civilians working at Kirtland, Sandia Laboratories with over 6,000 employees is located there.

Kirtland AFB is situated at an altitude of 5,352 ft (1,630 m) above sea level in the relatively level high plateau area of the upper Rio Grande Valley. The Manzano Mountain Range, rising to about 10,000 ft (3,050 m) lies about 10 mi (16 km) east of the base.

Because of urban encroachment there is little of the original flora and fauna left in the area; however, the Isleta Indian Reservation lies south of the base and remains mostly undeveloped. The average mean temperature at Kirtland is 55° F (13° C), with extremes ranging from 25° F to 100° F (-4° C to 38° C). Average precipitation is 8 in. (20 cm) per year. No known geological hazards or archaeological sites exist on the base; however, there is an archaeological site about 2 mi (3.2 km) northwest of the base.

The facilities of the 54,108 acre (21,643 ha) base are fairly well-distributed with a Department of Energy facility somewhat isolated. This is the only facility that generates all of its own electric power; the rest of the base uses public power. Most water is also purchased from public agencies with supplemental groundwater being available on the base. Sewage is also disposed of through the offbase public system. The airport facility is owned by the City of Albuquerque.

There are no air quality or noise problems caused by non-aviation operations at the base. An Air Installation Compatible Use Zone (AICUZ) program is presently under preparation that will address noise and air quality problems related to aviation operations. At present these cannot be specified, but MX should cause no significant change in the current situation. Insignificant amounts of toxic materials are produced on the base, and none are disposed of on the site (Kirtland AFB, 1978).

There are about 4,600 military and 4,600 civilian personnel working at the base (not including Sandia Laboratories) with a $210,000,000 annual payroll. There are about 730 officers' family quarters located on the base. The 1970 population of the City of Albuquerque was 243,751 and the urbanized area was 297,451 (Department of Commerce, 1973).

Edwards Air Force Base. The Air Force Rocket Propulsion Laboratory is one of the major tenants at Edwards AFB. It is located at the eastern edge of Edwards AFB in Kern and San Bernardino counties. The Laboratory facilities include complete vehicle propulsion components, propellants, chemical lasers, and rocket ground equipment. Rocket engine test facilities range from those which are completely enclosed and small in size to those which are very large and conducted in the open atmosphere. The Air Force Flight Test Center provides still and motion picture photographic services and other support to the Rocket Propulsion Laboratory.

The vast Edwards AFB military reservation lies in the most westerly portion of the great Mojave Desert, and is distinguished by its expanses of flat dry lake beds. This 300,000 acre (120,000 ha) base is approximately 15 by 35 mi (24 by 56 km). About 56 percent of the 8,600 base employees are civilians. The base is the site of many historic test flights, and is known as the foremost flight test center in the world.

The primary mission of Edwards AFB and the Air Force Flight Test Center (AFFTC) is to conduct research and development flight testing of manned and unmanned aircraft systems and aerodynamic deceleration devices for the Air Force and other government agencies. The test pilot school trains test pilots and flight test engineers. The NASA Dryden Flight Research Center, located here, is concerned with the Space Shuttle, lifting bodies, supersonic and transonic flight research.

The personnel presently include about 3,800 military and about 4,800 civilians, with an annual total payroll of about $134,200,000.

Edwards AFB is located on the western edge of the Mojave Desert, approximately 100 highway mi (160 km) north of Los Angeles and about 15 mi (24 km) southeast of the city of Mojave. This desert location affords natural isolation which is essential for the flight testing of new and experimental aircraft. There are about 45 mi^2 (116 km^2) of usable landing area on Rogers and Rosamond dry lakes. There are also a number of offbase dry lakes used to support the AFFTC mission as planned recovery areas for research aircraft as well as providing emergency landing sites.

The area is extremely arid with the average mean temperature of 61° F (16° C), and extremes between 4° F and 113° F (-16° C to 45° C). Annual precipitation averages only about 4 in. (10 cm). The lack of

moisture precludes productive farming and grazing is extremely sparse. Native plant and wildlife is likewise sparse as is consistent with that usually found in a desert environment (Edwards AFB, 1977).

The primary sources of air pollution at Edwards AFB are emissions from surface vehicles and aircraft engines. There is a problem of declining visibility in the Antelope Valley. Although the impact of flight testing on the atmosphere is not known at this time, a study to identify future degradation in long-range visibility has been also created by the two boiler plants (both natural gas and fuel oil) on base, space heaters, organic hydrocarbon emissions from solvent usage, painting and other minor sources.

Because of its depressed geographical location, the primary impact of water pollution in the area is directed toward Edwards AFB. Surface drainage naturally flows toward the two large dry lakes on the base. domestic sewage consists of an average of 900,000 gallons (3,400 m^3) per day with an average BOD of approximately 250 mg/1. All effluent is retained onbase because the base is located at a low point of the Antelope Valley.

Because of the continued encroachment of urbanization towards Edwards, a primary environmental concern is noise, and potential public reaction to the sonic boom phenomenon. The extensive supersonic test and training activities average five or six high altitude sonic booms per day and a variable number daily at low altitudes. All supersonic testing takes place within designated test corridors which have been operational for over ten years. Noise emitting from aircraft takeoffs and landings are not considered to be a problem because the nearest community is about 15 mi (24 km) away with the aerodrome complex approximately centered within the reservation boundaries.

On the base there are 486 officer's family quarters and 1,570 NCO family's quarters (Edwards AFB, 1977). Nearby Edwards had a 1970 population of 10,331. The city of Mojave had a 1970 population of 2,573, and Rosamond was under 2,500. However, Lancaster, 30 mi (48 km) to the south had a population of 32,728 that year (Department of Commerce, 1973). Within 100 mi (160 km), in the Los Angeles Basin, a technically skilled and highly professional labor market is available as well as numerous highly accepted institutions which furnish specialized consultant services as required.

Because the AFFTC Precision Impact Range has been utilized as an ordnance impact area since 1933, it is a reasonable assessment that the area could never be cleared to the extent that it would be totally safe for human use (Edwards AFB, 1977).

One small area near the main base complex has been used in past years to bury containers of various chemicals. The area is fenced and posted "off limits". Because of an impervious layer of underlying clay, surface and subterranean drainage in this area will not have a significant effect on underground water.

Land Use

2

RELATIONSHIP OF PROPOSED ACTION TO LAND USE PLANS, POLICIES, AND CONTROLS FOR THE AFFECTED AREA

2.1 INTRODUCTION

The Full-Scale Engineering Development Program involves a diverse set of engineering and test programs which may affect land use in several areas. The project actions which are of importance include tests of the MAP ground facilities and those specific tests at:

- Edwards Air Force Base in California
- Kirtland Air Force Base in New Mexico
- Arnold Air Force Station in Tennessee

Full-scale engineering development of the MX system, including prototype missile and ground vehicle design and manufacture, component testing, and full-scale systems tests, is not expected to adversely affect current or future land uses in affected areas. Manufacturing will occur in current manufacturing areas and little or no plant expansion is required and no direct impacts should occur. Indirect impacts related to population migration may occur but are of a sufficiently limited scale that no significant regional land use impacts are anticipated. Impacts on local communities and areas may vary, but these cannot be identified at the present level of analysis since location of specific MX contractors will be determined during full-scale engineering development. Component tests will occur at both government and industry owned facilities currently operational and devoted to comparable testing activities. Little or no modification of land uses, either directly or indirectly, is anticipated at these facilities discussed in Section 2.2.

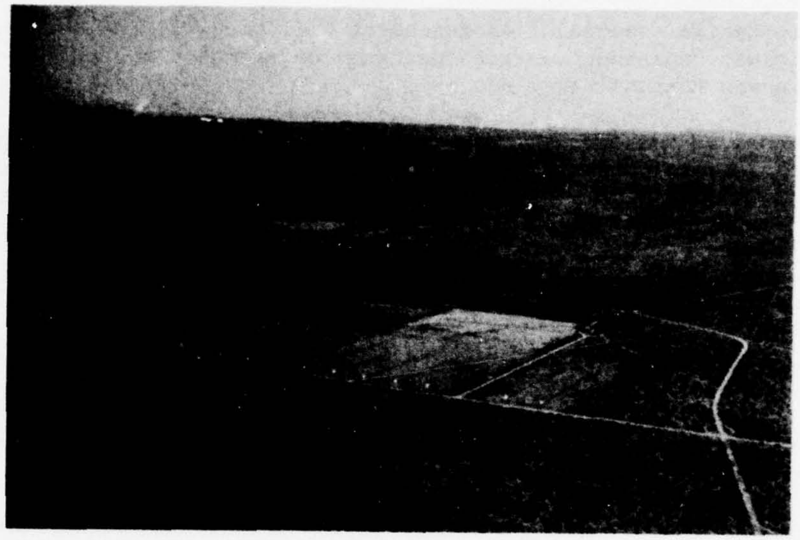
2.2 LAND USES ON SELECTED AIR FORCE TEST BASES

Component, subsystem, and full-scale prototype testing activities are being undertaken at test bases which have supported similar activities in the past. These include the Air Force Rocket Propulsion Laboratory (AFRPL) at Edwards AFB, Arnold Engineering and Development (AEDC) at Arnold AFS, and the Air Force Weapons Laboratory (AFWL) at Kirtland AFB. Very little of the testing is expected to necessitate modifications or the building of additional facilities, or land use alterations. Those changes which occur will represent modifications on government land already committed to such uses.

Edwards Air Force Base Site (2.2.1)

The area covered by the site is fully under the control of the U.S. Air Force, and is not used for any civilian purposes. The base itself lies in Los Angeles, San Bernardino, and Kern counties. On the southern boundary of the base in Los Angeles County, the land is mostly under private ownership, and is designated by the county as open space and rural, recreational and agricultural land. San Bernardino County is located northeast, east, and southeast of the base. Land use within a 10 mi (16 km) belt of Edwards AFB is open space crossed by Highway 395 to the east, and Highway 58 to the northeast. Kramer Junction, a small community (population, ca. 150), lies at the intersection of Highways 395 and 58. On the north and west sides of the base in Kern County, most of the land adjacent to the base is open space. However, the communities of Boron, North Edwards, and Rosamond are located close to the base boundary (Edwards AFB, 1976).

Due to very low density of population in the vicinity of the project site, its test activities will not affect land uses of the surrounding areas. The site itself is designated for a long-term military use and this use will not be altered by the project.



Irrigated area in foreground and target in the background are in contrast to sparse, natural vegetation.

Kirtland Air Force Base (2.2.2)

Kirtland AFB, encompassing 54,000 acres (21,600 ha), is located in Bernalillo County, southeast of and contiguous to the city of Albuquerque, New Mexico. The base is bounded on the south side by the Isleta Indian Reservation, and on the west by state land, designated for the University of New Mexico. Its principal mission includes research and development programs in weapons effects and safety, civil engineering, laser technology, and nuclear survivability and vulnerability.

Land use in Bernalillo County is dominated by the city of Albuquerque, which constitutes the major portion of the county's and state's population and economic base. The city's residential growth has encroached upon Air Force use of Albuquerque International Airport. Further restrictions, however, seem less likely, since the remainder of the airport's approach zones, are already developed and flight patterns are Federal Aviation Administration-controlled (Kirtland AFB, 1976).

Excluding Albuquerque, the remainder of Bernalillo County is presently rural land (25 percent). However, countywide trends emphasize expansion and improvement of existing industrial areas, and continued residential and commercial expansion in the north and west rural areas.

Another potential source of encroachment will occur if the New Mexico State Highway Department carries out its long-range plans to construct an expressway through Kirtland.

The MX tests themselves would not be expected to alter the land use characteristics of surrounding areas, given that proposed tests are very similar in nature to historical uses of KAFB. Land use conflicts, if they do result, would occur independently of MX.

Arnold Engineering Development Center (2.2.3)

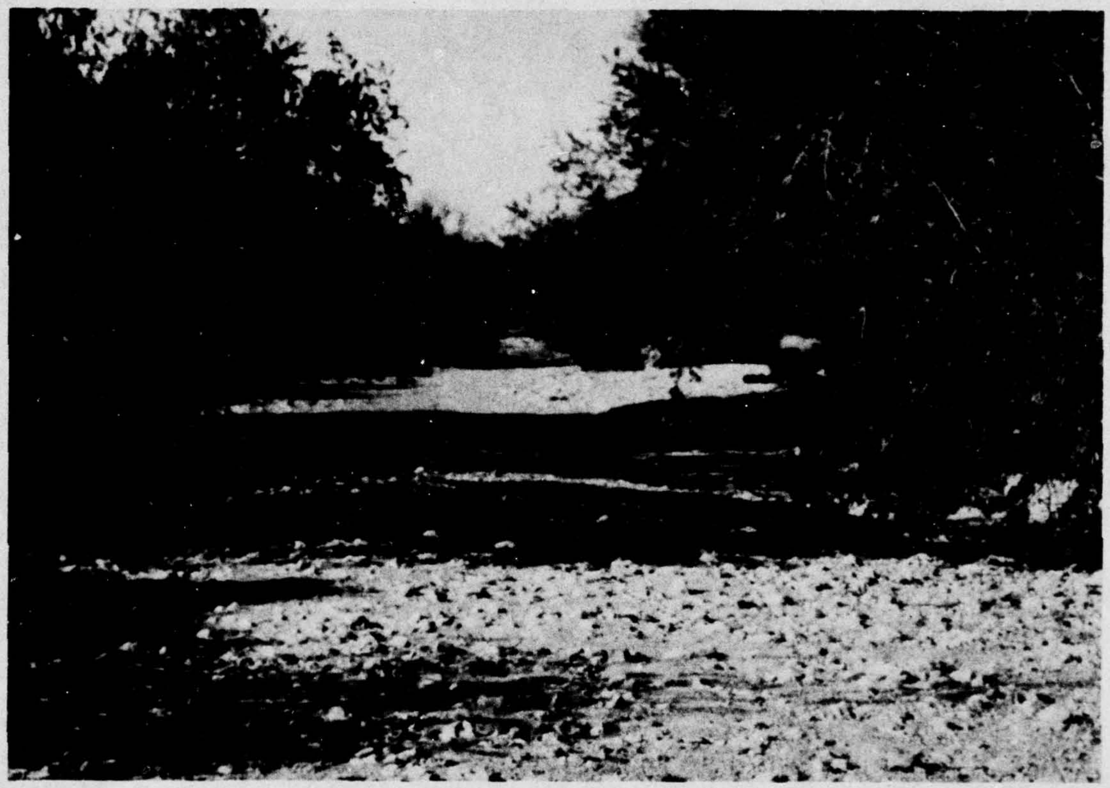
Arnold Engineering Development Center (AEDC) is one of many complementary research and development centers within the Air Force Systems Command (AFSC). It is located at Arnold AFS, in the Highland Rim region of south central Tennessee, midway between Nashville and Chattanooga, and encompasses 3,000 fenced areas (1,200 ha) of the 40,000 acre (16,000 ha) Arnold complex. AEDC represents the nation's largest complex of wind tunnels, jet and rocket engine test cells, space simulation chambers, and hyperballistic testing ranges, and as of February 1977, was valued at $1.13 billion. The operations are isolated, and a buffer zone is maintained between the center and nearby communities.

The general area surrounding AEDC is sparsely populated except for the communities of Tullahoma, Manchester, Hillsboro, and Estill Springs, all located within a 10 mi (16 km) radius, and comprising a total 1974 population of 30,000 persons. AEDC has been operated by a civilian contractor, with 3,300 employees in 1977. Most laboratory employees reside in the above communities, contributing toward local support of AEDC. In addition, the Center's Natural Resources Program has been oriented toward the surrounding communities; fishing in Woods Reservoir and hunting on the reservation is open to the public under Tennessee's fish and game regulations.

Major base installations comprise about one-fourth of Arnold's 40,000 acre (16,000 ha) total and they include the laboratory facilities, a 6,000 ft (1,830 m) runway and airport complex, and a family housing area for 40 on-base personnel. The remainder of the reservation consists of moderately dense underbrush and upland hardwood and pine forests, established and maintained principally for sound attenuation. Two areas at AEDC of special botanical interest have been designated as registered National Landmarks by the U.S. Department of the Interior. Goose Pond is a 149 acre (60 ha) natural marsh, with seven marsh vegetation types and three fringing forest types.

Sinking Pond is a 152 acre (61 ha) virgin swamp forest, with secondary fringing upland forests (Air Force Systems Command, 1971). Tennessee's Wildlife Resources Agency manages Arnold's wildlife conservation program.

Testing of MX at AEDC will represent a continuation of operations similar to those which have been conducted in the past. Land uses would not be altered, and therefore, conflicts should not arise. Further, AEDC has attempted to integrate test operations' land uses with surrounding community needs. Portions of Arnold Center land have even been declared surplus, permitting acquisition by neighboring communities for industrial and residential development. With its remaining acreage reserves, AEDC remains isolated, with a buffer zone between it and nearby communities.



Environmental Impacts

3
ENVIRONMENTAL IMPACTS OF THE PROJECT

3.1 INTRODUCTION

Development of the MX system with missile prototypes, specialized basing mode vehicles, and component and missile system testing will have social and economic effects which are nationwide. The effects on national output and employment are considered in this section. In addition, there will be social gains from improved national security. Similarly, positive effects on prestige, research, and technological gains are probable. Costs associated with the MX system include direct costs for design, development, and testing components and a reallocation of goods from other alternative but unidentifiable uses.

MX-induced effects on land-use alterations, population adjustments, and impacts upon other environmental features, including air and water quality, are primarily regional. These effects are related to specific tests at specific testing locations.

3.2 NATIONAL IMPLICATIONS OF FULL-SCALE ENGINEERING DEVELOPMENT

This FEIS analyzes direct national expenditures for full-scale development ranging from \$5 billion to \$7 billion, which is equivalent to \$25 to \$35 per person in the nation. The analysis also assumes that equal yearly increments are expended, ranging from \$1.0 billion to \$1.5 billion.

Project-Related Output (3.2.1)

Table 3-1 details changes in gross national product based on a national input-output multiplier of 4.47 (see Addendum II-A for the derivation of this estimate). A gross national product of \$1,661.7 billion in 1977 dollars is used to compare output adjustments which would have resulted from full-scale engineering development expenditures had the project been operating that year. The change in national output resulting from yearly expenditures ranging from \$1 to \$1.5 billion would range from approximately 0.17 percent to 0.23 percent of the Gross National Product. MX-induced output growth, while large in absolute terms, would be small relative to the nation's existing economy.

Project-Related Earnings (3.2.2)

Each \$1,000 million of increased national gross output resulting from full-scale engineering development of MX will include \$340 million in earnings for people employed directly or indirectly by the project. Table 3-2 gives national earninq changes from full-scale engineering development. (The derivation of these statistics is provided in Addendum II-A.) Annual MX investments ranging from \$1 billion to \$1.5 billion would comprise about 0.2 percent of 1980 earnings.

Full-scale engineering development investments would increase national labor income by large amounts viewed in absolute terms. Relative to preexisting levels, MX-induced earnings changes are small when compared to the entire national economy.

Table 3-1. Affected national output (1977 $ millions).

TIMING	INVESTMENT	GROSS OUTPUT	GROSS NATIONAL PRODUCT[1]
Annual Average	$1,000	$ 4,470	$ 2,540
	$1,500	$ 6,705	$ 3,810
Total	$5,000	$22,350	$12,710
	$7,000	$31,290	$17,790

[1]Based on the ratio of GNP to I-O gross output obtained from U.S. Department of Commerce, 1971, *Business Statistics*; and U.S. Department of Commerce, 1974, *Survey of Current Business, Vol. 34, No. 2.*

Table 3-2. Affected national earnings (1977 $ millions).

TIMING	INVESTMENT		INCREASED EARNINGS	
	LOW	HIGH	LOW	HIGH
Annual Average	$ 1,000	$ 1,500	$ 1,519.8	$ 2,279.7
Total	5,000	7,000	7,599.0	10,638.6

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Project-Related Employment (3.2.3)

At the national level, FSED will have mainly a socioeconomic effect in that the $5 to $7 billion analyzed in this FEIS would require jobs in aerospace and supporting industries. If there were a high rate of unemployment (8 percent) at the time of FSED expenditures, up to 130,000 direct and supporting jobs could be required. A low unemployment rate of 4 percent would result in approximately 20,000 direct and supporting jobs. The jobs include both these directly resulting from the project, and those resulting indirectly from the general economic stimulation produced by the project. Additional details are provided in Addenda II-A and II-B and summarized in Table 3-3.

To assess changes in national labor employment on a relative basis, 1975 and 1980 employment projections were utilized. Between 1975 and 1980, national labor employment is projected to increase from 92,500,400 persons to 95,114,000, for an average annual rate of growth of 0.6 percent. Full-scale engineering development, with the high changed employment of 130,000 jobs for 4 years, would represent 5 percent of the projected increase in employment if it had occurred during that period.

Table 3-3. Estimated MX FSED impact[1] low and high unemployment cases.

IMPACT MEASURE	AVERAGE EMPLOYMENT INCREASE
Low Unemployment[2] (4 percent)	15,000 to 22,000
High Unemployment (8 percent)	88,000 to 126,000

[1]Assumes $1 billion/year expenditure for MX FSED coupled with $1 billion/year increase in personal taxes.

[2]The low unemployment case assumes that unemployment without the project is maintained at 4 percent. The high unemployment case assumes an 8 percent rate.

3.3 REGIONAL IMPLICATIONS OF FULL-SCALE ENGINEERING DEVELOPMENT

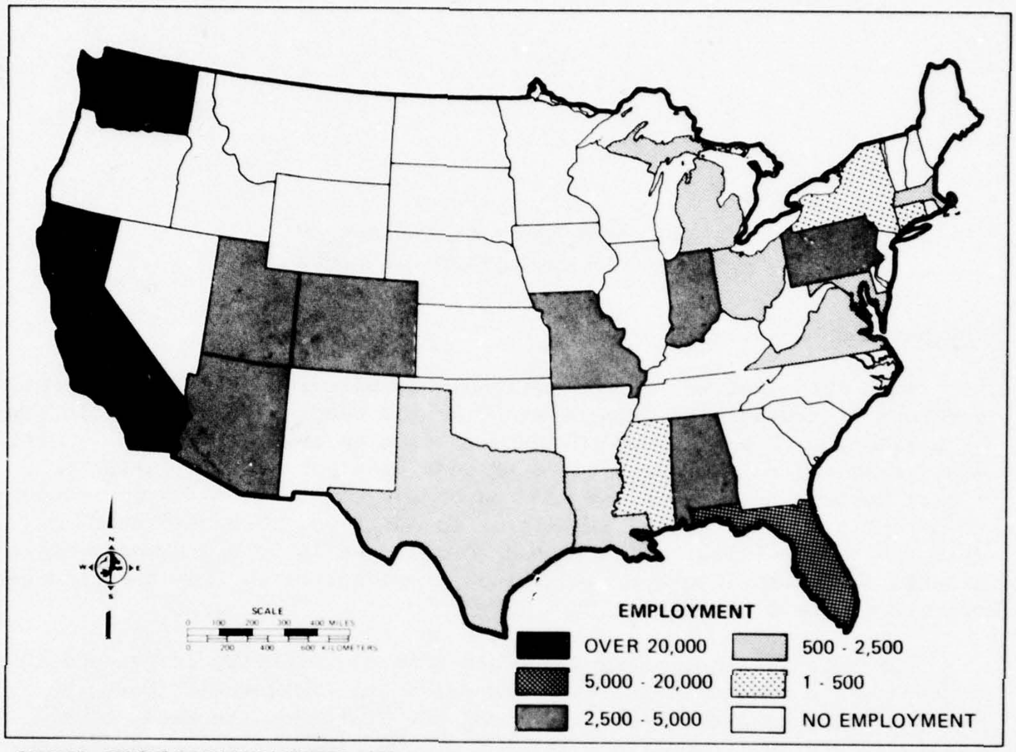
Introduction (3.3.1)

This FEIS analyzes direct national expenditures over the full-scale development schedule of 4 years and 9 months ranging from \$5 billion to \$7 billion, with annual expenditures ranging up to \$1.5 billion. Development, manufacture, and associated MX test programs will increase jobs, first, because business firms and households supply those inputs needed to directly produce guided missiles. In addition, secondary suppliers (firms and households) will respond to meet the increased demands of the directly affected industry, as well as those generated from the increased overall economic activity.

The regional implications of this economic activity are viewed in two essentially different ways in the material that follows. First, the national impacts are distributed among the states on the basis of the historical share that each state has had of the national aerospace industry (Section 3.3.2). Secondly, in order to provide more detailed regional effects, specific states are selected and traditional regional impact analysis is performed (Section 3.3.3).

The results provided by the two approaches differ for several reasons. First, the detailed regional approach is not constrained by a national impact estimate and, conceptually, does not contain interregional feedback effects. Secondly, the detailed regional approach permits the full potential economic effects to operate, with resulting growth-induced environmental effects.

The national control total used in the regional distribution approach, on the other hand, is based on a constrained indirect and induced effect component so as to not overestimate the national economic benefits of FSED. Thus, while the results for specific states differ, the two sets of results serve different purposes in the analysis.



SOURCE: CENSUS OF MANUFACTURES, 1972.

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Figure 3-1. Employment in SIC 376, Guided Missiles, 1972.

Regional Distribution of National FSED Impacts (3.3.2)

Based on the national input-output impact analysis, national direct job requirements will range from 29,500 to 44,200 jobs (Addendum II-B). Effects at state levels will be concentrated in about 15 states. Figure 3-1 summarizes 1972 employment by state for the Guided Missile industry (Standard Industrial Classification (SIC) Code 376). Almost 54 percent of total missile industry employment (159,000 persons) was centered in one state, California (Census of Manufactures, 1972). Washington, the second highest aerospace concentration, had only about one-fourth as much employment as California. This large disparity of historic aerospace industry employment indicates an expected wide range of direct labor impacts across states.

Table 3-4. Possible range of direct annual employment for $1 billion and $1.5 billion annual investments.

STATE	$1 BILLION	$1.5 BILLION
California	15,901	23,824
Washington	4,042	6,055
Florida	2,685	4,022
Arizona	885	1,326
Pennsylvania	885	1,326
Utah	885	1,326
Alabama	590	884
Colorado	561	840
Indiana	561	840
Missouri	561	840
Massachusetts	413	619
Michigan	413	619
Ohio	413	619
Maryland	177	265
Texas	177	265
Virginia	177	265
Connecticut	89	133
Louisiana	89	133
New York	89	133
Mississippi	30	44

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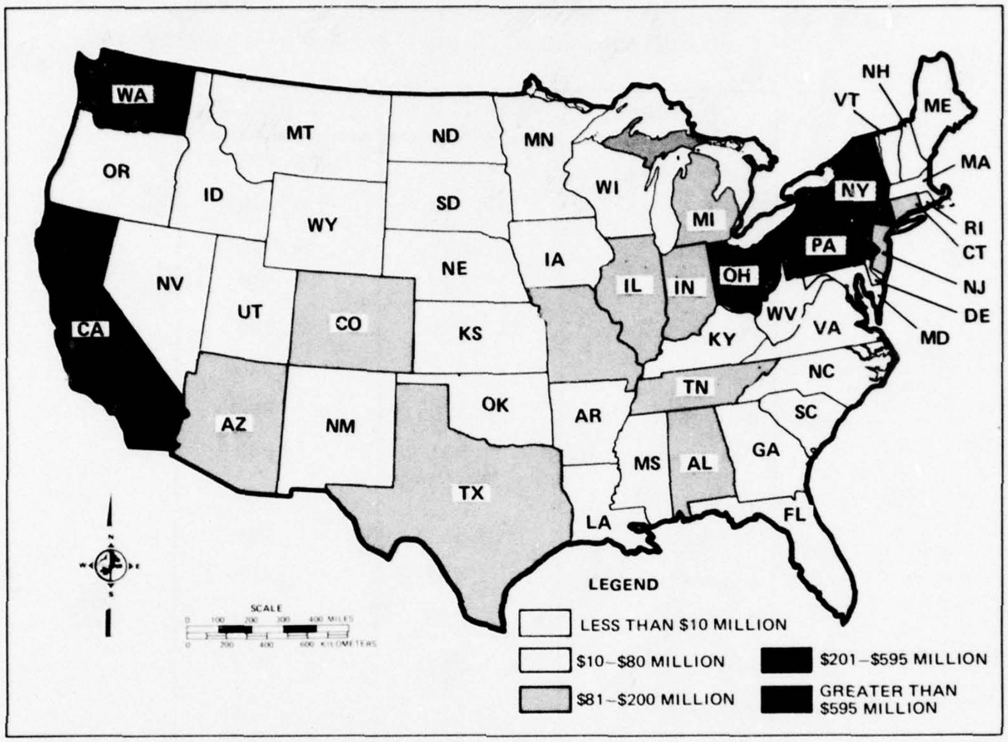
Source: Derived from Census of Manufactures, 1972.

Assuming each state's 1972 percentage share of employment in the nation's Guided Missile industry is representative of future employment distributions, Table 3-4 presents the range of direct employment requirements by state. Figure 3-2 utilizes 1972 state employment shares to allocate a $5 billion national investment.

Annual MX investments could increase national aerospace direct employment by 29,500 jobs; state shares could vary from almost 16,000 jobs in California to only 30 in Mississippi. In addition, most states would experience indirect job effects from full-scale development.

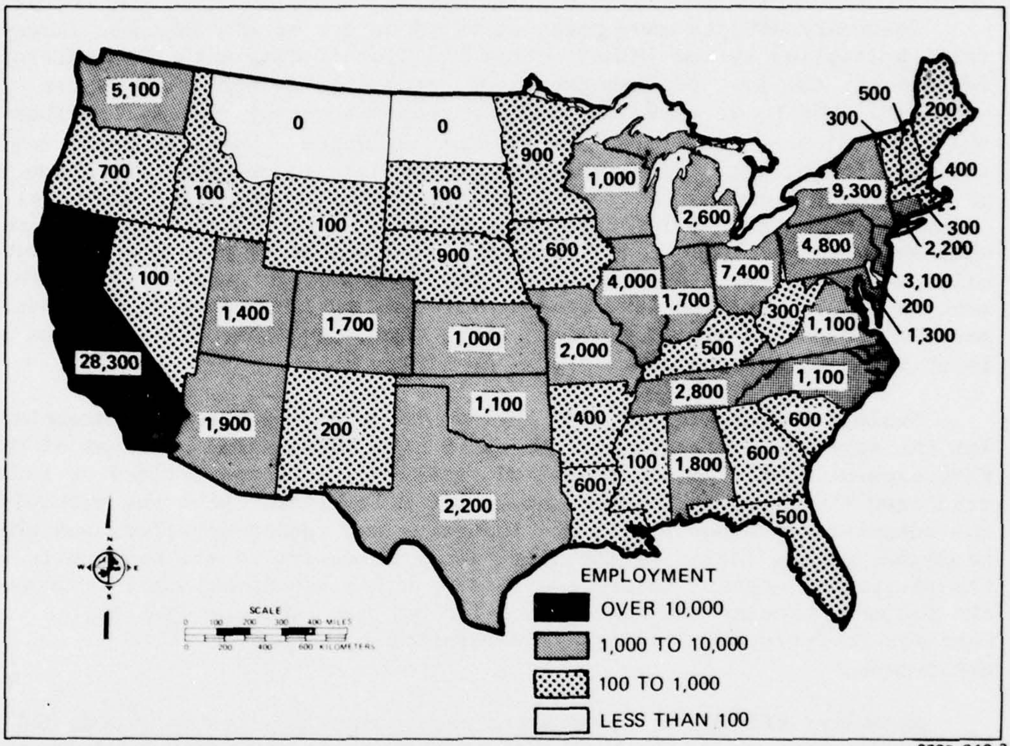


SOURCE: DERIVED FROM CENSUS OF MANUFACTURES, 1972. 372P-835

Figure 3-2. Distribution of $5 billion (1977 dollars) MX expenditure by state. State entries are derived from data presented in Figure 1-3. Each state's percent shares of aerospace and support employment across the United States as a whole were multiplied by $5 billion and dollar shares then categorized accordingly.

The dispersion of MX indirect-induced employment across states is larger. Figure 1-3 presents state shares of U.S. employment in aerospace and support industries for 1972. California's percent share, 27.8 percent, is three times that of New York (9.1 percent), the second highest concentration of aerospace and support employment. Twenty-five states' share ranges between 0.2 percent and 1.6 percent, and only North Dakota, Alaska, and Hawaii had no perceptible 1972 employment share. Montana's share is also very small.

If annual MX investments equaled $1 billion, national aerospace and associated supporting employment could require from 20,000 to 130,000 jobs. As indicated above, 29,500 jobs comprise aerospace, with the remainder equal to support and related employment. Figure 3-3



SOURCE: DERIVED FROM CENSUS OF MANUFACTURES, 1972.

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Figure 3-3. Distribution of induced-indirect employment resulting from full-scale engineering development of MX.

estimates total indirect-induced job changes by state. California's share could reach 28,300 jobs (101,700·0.278).

Detailed Impacts of FSED for Specific States (3.3.3)

The preceding extension of the national impacts to analyze the potential regional distribution provides general, but not detailed, environmental effects. This section takes an alternative approach and looks at selected states more intensively to provide estimates of secondary environmental effects.

Secondary effects have been estimated by use of the Regional Industrial Multiplier System (RIMS). From the list of available RIMS multiplier industries, the most representative of categories of expenditures are selected. The total increase in gross regional output (sales) attributable to project expenditures can then be estimated. For full-scale engineering development activities, the most appropriate industry is the production of guided missiles and space vehicles, which has a two-digit industrial classification (SIC) code of 37 and a four-digit SIC code of 3761. Within this category are those firms engaged in manufacturing entire guided missiles and space vehicles, as well as those engaged in research and development on guided missiles and space vehicles. RIMS, however, still classifies missile production within SIC code 1925, Complete Guided Missiles, and it is utilized in this report.

Table 3-5 presents the RIMS full-scale development impact parameters for the seven main states expected to receive substantial portions of MX FSED expenditures. As the table indicates, the more specialized or industrialized the area, the higher the output multiplier. Like the multipliers, the output-to-earnings ratios are industry- and region-specific, and the magnitude of the ratios reflects the labor intensity of the project in the particular areas. Indirect earnings, which are distributed throughout the region's economy are region-specific but not industry-specific. Earnings-to-employment ratios allow earnings to be converted to employment.

Secondary effects of investments may produce population shifts and localized growth which, in turn, may require land use changes. New jobs in an area will reduce unemployment and encourage in-migration; the magnitude of in-migration will depend upon the number of new jobs and the availability of local labor with appropriate skills. New people will require housing, schools, commercial areas, highways, recreation areas, and a host of additional services. In the large urbanized areas where prototype production will occur, these new uses will not represent significant change. In smaller urbanized areas, the project-induced population growth could be sufficiently large to produce notable secondary impacts.

Table 3-6 compares the 14 key requirements industries for Complete Guided Missiles, with industries available in 13 selected areas. As such, the ability of any region in supplying goods and services to the Guided Missile industry can be determined. Location Quotients[1] (LQs) measure

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[1]Location Quotients are technically defined as:

$$LQ_{ij} = \frac{X_{ij} \div X_j}{Z_i \div Z}$$

LQ_{ij} = Location Quotient for industry$_i$ region$_j$

X_{ij} = employment in industry$_i$ in region$_j$

X_j = total employment in region$_j$

Z_i = national employment in industry$_i$

Z = total national employment

Table 3-6. Location quotient for guided missile related industries—1972.

INDUSTRY TITLE AND SIC CODE	PERCENT OF TOTAL INPUTS[1]	COLORADO REGION	CALIFORNIA REGIONS					MASSACHUSETTS REGION	NEW YORK REGIONS			TEXAS REGION
			I	II	III	IV	V		I	II	III	
Aircraft Equipment Not Elsewhere Classified (3729)	25.5	3.81	7.97	—	18.55	1.20	—	< 1.0	< 1.0	2.83	—	8.3
Aircraft (3721)	19.5	< 1.0	6.52	—	—	—	—	—	—	< 1.0	—	5.5
Misc. Business Services (73 Excl. 731, 7396, 8692, 7694, and Pt. 7699)	7.6	1.42	1.56	1.01	1.08	1.53	1.82	1.37	1.38	2.04	1.15	1.3
Complete Guided Missiles (1925)	6.4	3.09	5.49	—	9.43	3.88	2.87	< 1.0	—	< 1.0	—	1.0
Electronic Components Not Elsewhere Classified (3679)	6.0	—	2.21	—	1.49	2.37	1.76	1.94	< 1.0	1.18	—	< 1.0
Radio and TV Communication Equipment (3662)	3.9	—	3.74	—	2.12	1.77	4.34	2.22	< 1.0	1.70	1.83	3.0
Retail Trade (52-59, 8396, Pt. 8099)	3.9	1.80	1.11	1.22	1.14	1.08	1.24	1.07	1.19	1.14	1.11	1.2
Communications Excl. Radio and TV (48)	3.2	< 1.80	2.07	1.43	1.05	1.24	1.88	< 1.0	1.02	1.72	1.15	1.2
Machine Shop Products (359)	2.3	< 1.0	1.85	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.46	< 1.0	< 1.0	1.2
Misc. Plastic Products (3079)	2.1	< 1.0	1.71	< 1.0	< 1.0	< 1.0	< 1.0	1.11	1.57	1.39	1.43	< 1.0
Wholesale Trade (50)	1.8	1.38	1.23	1.16	1.01	1.27	1.40	1.19	1.18	1.62	1.46	1.6
Real Estate (65 Excl. Pt. 6561; 66)	1.6	1.31	1.24	1.11	1.23	1.31	1.08	< 1.0	< 1.0	2.16	1.01	1.
Engineering and Scientific Instruments (3811)	1.4	—	1.92	—	< 1.0	< 1.0	—	1.88	—	1.76	—	1.
Misc. Professional Service (81, 89, Excl. 8921)	1.4	1.33	1.55	< 1.0	1.11	1.43	1.11	1.47	< 1.0	1.66	1.36	1.

[1] Out of 80 industries listed in the national input-output model, which provide inputs to the nation's guided missile industry, these provide 86.6 percent.

Source: EIFS.

Table 3-6. Location quotient for guided missile related industries—1972.

PERCENT OF OTAL INPUTS[1]	COLORADO REGION	CALIFORNIA REGIONS					MASSACHUSETTS REGION	NEW YORK REGIONS			TEXAS REGION	UTAH REGION	WASHINGTON REGION
		I	II	III	IV	V		I	II	III			
25.5	3.81	7.97	—	18.55	1.20	—	< 1.0	< 1.0	2.83	—	8.35	—	2.29
19.5	< 1.0	6.52	—	—	—	—	—	—	< 1.0	—	5.59	—	5.44
7.6	1.42	1.56	1.01	1.08	1.53	1.82	1.37	1.38	2.04	1.15	1.34	1.31	1.17
6.4	3.09	5.49	—	9.43	3.88	2.87	< 1.0	—	< 1.0	—	1.09	< 1.0	—
6.0	—	2.21	—	1.49	2.37	1.76	1.94	< 1.0	1.18	—	< 1.0	< 1.0	< 1.0
3.9	—	3.74	—	2.12	1.77	4.34	2.22	< 1.0	1.70	1.83	3.04	2.54	1.07
3.9	1.80	1.11	1.22	1.14	1.08	1.24	1.07	1.19	1.14	1.11	1.20	1.14	1.16
3.2	< 1.80	2.07	1.43	1.05	1.24	1.88	< 1.0	1.02	1.72	1.15	1.25	1.03	1.35
2.3	< 1.0	1.85	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.46	< 1.0	< 1.0	1.29	< 1.0	< 1.0
2.1	< 1.0	1.71	< 1.0	< 1.0	< 1.0	< 1.0	1.11	1.57	1.39	1.43	< 1.0	< 1.0	< 1.0
1.8	1.38	1.23	1.16	1.01	1.27	1.40	1.19	1.18	1.62	1.46	1.60	1.50	1.36
1.6	1.31	1.24	1.11	1.23	1.31	1.08	< 1.0	< 1.0	2.16	1.01	1.54	1.14	1.31
1.4	—	1.92	—	< 1.0	< 1.0	—	1.88	—	1.76	—	1.58	—	—
1.4	1.33	1.55	< 1.0	1.11	1.43	1.11	1.47	< 1.0	1.66	1.36	1.12	< 1.0	1.57

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in the national input-output model, which provide inputs to the nation's guided missile industry, these 14 industries listed

2

Table 3-5. Full-scale engineering development coefficients to estimate economic effect.

STATE[1]	AEROSPACE GROSS OUTPUT MULTIPLIER	OUTPUT-TO-EARNINGS RATIO	EMPLOYMENT-TO-EARNINGS[2] RATIO	
			AEROSPACE	RESIDUAL
California	3.968	0.3394	52.10	82.75
Washington	3.152	0.3494	52.89	79.87
Colorado	2.982	0.3522	53.93	87.92
Utah	2.841	0.3545	56.95	97.14
Massachusetts	3.537	0.3441	56.82	91.28
New York/New Jersey/Connecticut	3.972	0.3394	57.52	72.29
Texas	3.535	0.3441	60.37	85.62
National	4.470	0.3400	64.98	86.34

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[1]Use of specific state coefficients would tend to underestimate effects and therefore the coefficients for the major aerospace manufacturing center has been used as a surrogate.

[2]Employment per million dollars of earnings.

Source: Bureau of Economic Analysis, 1978.

an industry's ability to supply; theoretically, an LQ greater than 1.0 indicates that the industry supplies more than enough for local demand; hence, it exports to other markets outside the region, while an LQ less than 1.0 indicates the importation of that particular industry's goods into the region.

Of the 13 regions evaluated, California I clearly dominates in its overall ability to supply local goods and services to the Guided Missile industry, while another California region does not have 6 of the 14 industries present, and an additional three industries are unable to supply enough to meet even local demand for the missile industry. Other regions rank in between these two extremes.

In addition to the Guided Missile industry itself, aircraft equipment and aircraft industries are very important suppliers of inputs, since together, these latter two industries supply 45 percent of direct inputs to the missile industry. Only three regions have both aircraft equipment and aircraft industries large enough to more than supply local demand. Four others had aircraft equipment industries of sufficient size to accommodate additional development in the local missile industry if contracts were awarded locally.

Impacts Common to All Areas (3.3.3.1)

Energy Consumption. Electric energy and fuels are important inputs in manufacturing components and system assembly for full-scale development. Estimates of energy consumption within the industry involved in the MX program were derived from the data on the consumption of fuels and electric energy by industry and industry groups available in the *1972 Census of Manufactures*, published by the U.S. Bureau of Census in 1974. Coefficients for energy use were derived from data on industry groups which include and are closely related to missile production. The three groups which were closest to the missile industry and were used as surrogates to calculate energy coefficients were Aircraft, Aircraft Engines and Engine Parts, and Aircraft Equipment not elsewhere classified. The total consumption of energy in these groups was divided by the corresponding output (value of shipments) figures to determine the energy use per dollar of output. Kilowatt hour equivalent of all electricity and other fuels purchased was calculated and dollar values of shipments were adjusted to 1977 dollars to arrive at the current requirements of energy.

Each $1,000,000 of aerospace output (1977 dollars) would require about 1.2 million kilowatt hours (kWh) equivalent of purchased fuels and electric energy to construct the required facilities and equipment. The total energy requirements in an average year would be an estimated 1.2 billion kWh. If peak investment figures are applied, energy consumption could average as high as 1.8 billion kWh per year. Specific impacts would vary, depending upon the location of the respective electrical demand and supply characteristics.

Water Consumption. The full-scale development of the MX program would require substantial amounts of water used directly in the industries which participate in the production of missile systems and indirectly by the supporting industries and increased population requiring water for private and public use. In the following paragraphs, the discussion is confined to the use of water by major MX contractors only. The focus is on the intake of water from public and private sources, the total usage of water, including recirculation, the amount of water discharged after use, and the amount of water treated before discharge.

Using the total output (value of shipments) and water consumption figures for the Missiles and Space Vehicles industry (SIC Code 3761), coefficients were derived and adjusted to the 1977 dollar value. These derived coefficients were then multiplied by estimated state aerospace output to project state water requirements of MX full-scale engineering development.

Three values related to water requirements are important: intake, discharge, and consumption. Water intake averages about 0.5 gallons (0.002 m^3) per dollar of output, but 84 percent is discharged so

consumption is 16 percent of intake. Total water requirements are much higher, averaging 4.2 gallons (0.02 m^3) per dollar of output, but water is used primarily for cooling purposes and is recirculated several times before discharge. Because water is used primarily for cooling, treatment prior to discharge is required for less than 10 percent of the water discharged.

Table 3-7 summarizes water requirements for full-scale engineering development under several conditions. The requirements are substantial and will likely be distributed proportionate to the regional expenditures.

Air Quality. MX expenditures for full-scale engineering development will increase employment opportunities in the aerospace industry and in supporting and service industries. To the extent that the local labor market cannot meet the increased demand for labor or that a local low rate of unemployment encourages relocation from higher unemployment areas, there will be population redistribution and local in-migration. This analysis takes into consideration present air quality conditions and population levels, and projects future air quality using a linear rollback model and projected in-migration characteristics.

As population levels increase, pollution levels increase, even with active control strategies and vigorous enforcement practices. Control strategies and emission devices reduce the impacts and with population limits may prevent the normal level of pollution from reaching unhealthy concentrations.

Emissions to the atmosphere generated in residential areas generally consist of combustion products from heating units, effluents from commonplace household activities, vehicle emissions, and emissions associated with the care of plants and landscaping. The latter are composed mostly of water, but some hydrocarbons are given off by street and shade trees. The primary pollutants that increase as the population level increases are the combustion and vehicle emissions. These are primarily carbon monoxide, nitrogen oxide, particulate matter, and hydrocarbons.

Carbon monoxide is directly related to vehicle traffic and goes up linearly with it. The controlled emissions from vehicles, hydrocarbons and nitrogen oxides, are likely to show an increase also, but at a lower level than would be expected for carbon monoxide. The photochemical reaction that produces smog may, however, be enhanced by these increases and result in both air quality degradation and visibility reduction as population increases.

Stationary sources of nitrogen oxides are home heating units, any appliance that uses natural gas, and commercial or business activities that require moderate heating units. Large power plants burning fossil

Table 3-7. Aerospace water requirements for full-scale engineering development in billion gallons (million m^3).

Table 3-7. Aerospace water requirements for full-scale engineering development in billion gallons (million m^3).

VALUE	INVESTMENT LEVEL			
	ANNUAL AVERAGE ($ BILLION)	PEAK YEAR ($1.5 BILLION)	PROBABLE TOTAL ($5 BILLION)	MAXIMUM TOTAL ($7 BILLION)
Intake	0.5 (1.9)	0.8 (3.0)	2.5 (9.5)	3.5 (13.0)
Discharge	0.4 (1.5)	0.7 (2.6)	2.1 (8.0)	2.9 (11.0)
Consumption	0.1 (0.4)	0.1 (0.4)	0.4 (1.5)	0.6 (2.3)

Source: Derived from Census of Manufactures, 1972.

fuels are not usually located near population centers, but increased demands on their capacity will normally increase nitrogen oxide emissions and decrease air quality in their vicinity and for some distance downwind.

Economic Impacts. Full-scale engineering development has been estimated to require a total nationwide investment of $5 billion to $7 billion over a period of 57 months. The annual level of nationwide investment is thus $1 billion to $1.5 billion. Each state's share of this total has been computed by multiplying the appropriate total ($5 billion or $7 billion) or annual ($1 billion or $1.5 billion) by the state's proportion of aerospace and support industry employment, as shown on Figure 1-1. This procedure allows a reasonable estimate of all direct, secondary, and tertiary contracting, as well as induced economic activity likely to result from the project. As an example, California's employment share was 27.8 percent. At a $5 billion national investment level, California is expected to receive $1,390 million ($5 billion·0.278). For a $1 billion annual investment at the national level, California would receive about $278 million ($1 billion·0.278).

The Regional Industrial Multiplier System (RIMS) Input/Output methodology (see appendix) was then used to estimate associated changes in output, earnings, and the number of jobs. The employment estimates from the Economic Impact Forecast System (EIFS) economic base multiplier are also provided in the following discussions of specific states. Estimates from the two systems are sufficiently comparable to support the level of change discussed.

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MX: MILESTONE II. FINAL ENVIRONMENTAL IMPACT STATEMENT. VOLUME --ETC(U)

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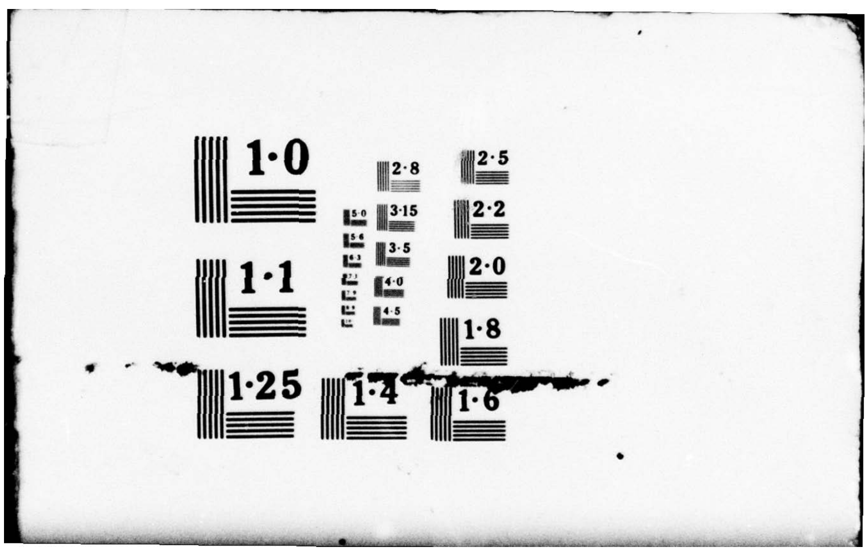
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Impacts of the Project on Specific Manufacturing Areas (3.3.3.2)

Full-scale engineering development of MX will involve the design and manufacture of 20 (nominal) missiles and appropriate basing mode ground equipment. This activity will have social and economic effects centered in those states where manufacturing will occur. Expenditures by the Air Force (investments) will create jobs both directly in aerospace firms and indirectly throughout the regional economy. These jobs, if not filled by currently unemployed people, will create population growth, and associated new demands of public service systems. This section discusses key impacts on selected states likely to result from MX full-scale engineering development.

California. California's share of aerospace and support industry employment was 27.8 percent of the nation's 1972 total. If national MX investments range from $5 billion to $7 billion, California's share would total from 1,390 to $1,946 million ($5 billion·0.278 = $1,39 billion), and annually range from $278 to $417 million.

MX-Related Changes in Gross Output

- The state's total output will increase by $4,416 to $7,722 million. Annually, output increases by $1,103 to $1,655 million.
- State industries receiving a large direct stimulus include: Other Transportation Vehicles; Electrical Machinery; Miscellaneous Business Services; Ordnance and Accessories; Retail Trade; and Communications, in that order.
- Effects on total output (direct and indirect-induced) will be concentrated in: Ordnance and Accessories; Other Transportation Vehicles; Retail Trade; Food and Kindred Products; Real Estate and Combinations; and Electrical Machinery, in that order.

MX-Related Changes in Number of Jobs

- Regional employment, resulting from the initial investment by the Air Force, is estimated to be:

Direct Employment	10,000 jobs
Indirect-Induced Employment	36,500 jobs
Total Employment	46,500 jobs

- Current (1975) state employment is 9.3 million, and this is projected to increase to 9.7 million by 1980 (Bureau of Analysis, 1974, 1977). Total MX employment is about 0.5 percent of 1975 and projected 1980 employment levels.

- The EIFS economic base multiplier projects that MX contracting in the region would generate about 39,200 jobs. The EIFS employment estimate is about 19 percent lower than the RIMS estimate. Together, these two models estimate the general range of employment effects that could result from MX contracting.
- While a large number of new jobs would be generated by MX contracting in this state, the current base is so large that the effects would be beneficial and acceptable.

MX-Related Changes in Earnings

- Annual earnings resulting from initial investment by the Air Force are estimated to be:

Direct Earnings	\$190.9 million
Indirect-Induced Earnings	\$370.7 million
Total Earnings	\$561.6 million

- The increase in earnings is greater than the initial expenditures by the Air Force.
- State earnings are projected to increase to \$166.9 billion by 1980 (Bureau of Economic Analysis, 1974, 1977).
- The maximum reasonable annual investment level represents 0.3 percent of projected 1980 levels.
- Increased earnings resulting from MX are very large in this state, but its large economic base means MX increases would be acceptable.
- Workers in directly affected industries will get about 34 percent of total MX-induced earnings; 66 percent will be distributed throughout the regional economy.
- Workers in directly affected industries will earn about \$19,200 per year while workers in other industries affected by MX will average about \$10,200 per year.

Population and Housing

- MX-created employment may induce 9,000 to 10,000 persons to in-migrate to California. This includes 4,000 workers plus their families. Other MX-related jobs will be filled by locally available workers. This level of in-migration amounts to about 3 percent of the state's annual growth of over 300,000 persons since 1975.
- Several metropolitan regions of the state may share the MX-related population growth although the bulk of the

increase will probably occur in southern California. Even if it is assumed that all the MX-related increase would occur in the heart of southern California (Los Angeles and Orange counties), an increase of 9,000-10,000 persons will amount to about 0.1 percent of the 1976 population of 8.8 million and less than 0.1 percent of the projected 1980 population of 9.1 million (State of California, California Statistical Abstract, 1976). The region's population growth in recent years has shown an increasing trend; population grew by 42,300 in 1973-74, 70,300 in 1974-75, and 96,400 in 1975-76.

- Statewide housing demand will increase by approximately 4,000 units. Full-scale development housing impacts will be negligible, except on a very localized level.
- If all MX-related contracts and associated employment were to occur in southern California, the maximum additional demand of 4,000 housing units would represent approximately 2.0 percent of the average annual vacant units of around 200,000 in Los Angeles and Orange counties. With a total of about 3.3 million housing units of all types (51 percent owner-occupied, 49 percent renter-occupied), the region could provide a wide range of housing for the MX-induced population in-migration. Housing prices in the region average over $100,000 for a 3-bedroon single-family home) and in-migrants currently experience difficulty locating affordable housing. MX-induced growth is not expected to significantly impact housing costs.

Energy Impacts. Aerospace manufacturing activities require about a 1.2 kWh equivalent of purchased fuels and electrical energy for each dollar of output. California aerospace industries are thus likely to require about 1.7 billion to 2.3 billion kWh over the life of the MX prototype manufacturing activity. This is equal to just over 0.3 percent of the total electric production in California in 1975. Although California exports oil, energy in the form of natural gas and electricity is generally imported. Even with importation, current projections foresee the potential for energy shortages, particularly in natural gas (used both in the production of electricity and for space heating) in many metropolitan areas of the state within the next decade. Limited population migration into California may occur as a result of the project. If so, additional electrical energy will also be required for their domestic needs. This would require about 36 million kWh additional energy consumption per year in California for FSED.

Air Quality Impacts. The increased employment of 10,000 workers in California would not result in a detectable level of air quality impacts.

The per capita air quality values for the major metropolitan areas within the state are approximately equivalent to other large metropolitan areas with nitrogen oxides and ozone slightly higher in southern California and the Los Angeles Air Basin, for example, and should all employees be in-migrants, there would be a potential increase of 1.3 percent of NO_x level. Such a scenario could produce a 2.2 percent increase in ozone production over projected conditions. Although not large, these increases would affect an area that already has air quality problems with both pollutants exceeding standards the majority of the time. Particulates, sulfur dioxide, and carbon monoxide would show increases also, but these are of less significance since these pollutants are not expected to exceed their limits. Since the primary emissions source is the automobile, any action taken to reduce vehicle travel will tend to reduce the impact of additional people in this southern California scenario.

Water Impacts. Aerospace manufacturing activities consume about 1 acre-ft (1,233.5 m^3) of water for each million dollars in sales. California's share of total MX full-scale development investments is projected to be about \$1,390 million to \$1,846 million, so about 1,400 acre-ft to 2,100 acre-ft (1.7×10^6 m^3 to 2.6×10^6 m^3) of water are likely to be required in the state. California's water problems are generally distributional with the periodic floods in northern California matched by shortages in southern California and both areas are affected by periodic droughts. Sufficient water to support manufacturing is likely to be available. Sufficient water to support induced population growth is a more complex issue. There is no reliable way to project population migration resulting from MX manufacturing. In general, 1 acre-ft (1,233.5 m^3) of water will supply five people for a year. Assuming each MX-induced job migrant has a family of 2.5 people, then each 100 MX jobs that induces population migration will require 50 acre-ft (6.1×10^4 m^3) of water. If large-scale in-migration occurs, sufficient domestic water could become a growth-constraining problem, particulary in southern California.

Washington. Washington's share of aerospace and support industry employment was 5.0 percent of the nation's 1972 total. If national MX investments range from \$5 billion to \$7 billion, Washington's share would equal from \$250 million to \$350 million totally, and on an annual basis, from \$50 million to \$75 million.

MX-Related Changes in Gross Output

- The state's total output will increase by \$788.0 to \$1,103.2 million. Annually, output increases range from \$157.6 to \$236.4 million.
- State industries receiving a large direct stimulus include: Other Transportation Vehicles; Miscellaneous

Business Services; Electrical Machinery; Retail Trade; and Communications, in that order.

- Effects on total output (direct and indirect-induced) will be concentrated in: Ordnance and Accessories; Other Transportation Vehicles; Retail Trade; Food and Kindred Products; Real Estate and Combinations; and Wholesale Trade, in that order.

MX-Related Changes in Number of Jobs

- Employment, resulting from the initial investment by the Air Force, is estimated to be:

Direct Employment	1,800 jobs
Indirect-Induced Employment	4,800 jobs
Total Employment	6,600 jobs

- Current (1975) state employment is 1,420,600, and this is projected to increase to 1,515,800 by 1980 (Bureau of Economic Analysis, 1974, 1977). MX employment would be about 0.4 percent of either historic or projected employment levels.

- The EIFS economic base multiplier projects that MX contracting in the region would generate about 5,900 jobs. The EIFS employment estimate is about 10 percent lower than the RIMS estimate. Together, these two models estimate the general range of employment effects that could result from MX contracting.

- MX full-scale engineering development will generate a large number of jobs in this state. Recent high unemployment probably means the jobs would be acceptable and beneficial.

MX-Related Changes in Earnings

- Annual earnings resulting from initial investment by the Air Force are estimated to be:

Direct Earnings	$34.7 million
Indirect-Induced Earnings	$47.9 million
Total Earnings	$82.6 million

- Current (1975) state earnings totaled $18.8 billion and are projected to increase to $24.2 billion by 1980 (Bureau of Economic Analysis, 1974, 1977).

- The maximum reasonable annual investment level represents 0.4 percent of 1975 levels and 0.3 percent of projected 1980 levels.

- Relatively small increases in earnings would result from full-scale engineering development of MX in Washington. These increases are probably beneficial and acceptable, as they represent large inflows to the state's economic base.
- Workers in directly affected industries will get about 42 percent of total MX-induced earnings; 58 percent will be distributed throughout the state's economy.
- Workers in directly affected industries will earn about \$18,900 per year, while workers in other industries affected by MX will average about \$10,100 per year.

Population and Housing

- MX-created employment may induce 1,600 to 1,700 persons to in-migrate to Washington. This includes 720 workers plus their families. Other MX-related jobs will be filled by locally available workers.
- Statewide housing demand will increase by approximately 720 units. The state's largest metropolitan area, where most aerospace and support employment is located, is currently characterized by an amount of vacant housing units. Full-scale development housing impacts will be slight, except on a localized level.

Energy Impacts. At the rate of 1.2 kWh for each dollar of aerospace industry output, and with an expected \$250 million to \$350 million output in Washington, project-related aerospace requirements there will be about 300 million to 420 million kWh. This is equal to about 0.3 percent of the 1975 production of electricity in Washington, and will be spread over the 57-month period of the project. Limited population migration into Washington could result in a demand for additional electrical energy of approximately 6.0 million kWh per year.

Air Quality Impacts. Metropolitan Washington is an area with some air quality problems. Nitrogen dioxide (NO_2) levels reach 9.2×10^{-5} $\mu g/m^3$ per person, a value 10 times that of New York City and almost equivalent to that found in southern California. Particulate levels, which exceed the limits about 40 percent of the time, also add to the air quality problem but to a much lesser extent.

The influx of 6,600 workers into the metropolitan area should have a relatively small effect on air quality both NO_2 and particulates will be slightly increased as a result of activities of the workers and their families.

Water Impacts. At the rate of 1 acre-ft (1,233.5 m^3) per million dollars of aerospace output, and with $250 million to $350 million proposed to be spent in Washington, 250 acre-ft to 350 acre-ft (3.1×10^5 m^3 to 4.3×10^5 m^3) of water will be required by the aerospace industry for the project over a 57-month period. Water requirements of the induced population cannot be accurately estimated, since induced population cannot be accurately estimated. In general, 1 acre-ft (1,233.5 m^3) of water will supply five people for a year. Assuming each MX-induced job migrant has a family of 2.5 people, then each 100 MX jobs that induce population migration will require an additional 50 acre-ft (6.1×10^4 m^3) of water. Washington has sufficient water supplies to support anticipated growth.

Colorado. Colorado's share of aerospace and support industry employment was 1.7 percent of the nation's 1972 total. If national MX investments range from $5 billion to $7 billion, Colorado's share would equal from $85 million to $119 million totally, and on an annual basis, from $17 million to $25.5 million.

MX-Related Changes in Gross Output

- Colorado's total output will increase by $253.5 to $354.9 million. Annually, output increases by $50.7 to $76.0 million.
- State industries receiving a large direct stimulus include: Other Transportation Vehicles; Ordnance and Accessories; Miscellaneous Electrical Machinery; and Retail Trade, in that order.
- Effects on total output (direct and indirect-induced) will be concentrated in: Ordnance and Accessories; Retail Trade; Food and Kindred Products; Other Transportation Vehicles; and Wholesale Trade, in that order.

MX-Related Changes in Number of Jobs

- Employment, resulting from the initial investment by the Air Force, is estimated to be:

Direct Employment	600 jobs
Indirect-Induced Employment	1,800 jobs
Total Employment	2,400 jobs

- Current (1975) state employment is 1,164,000, but this is projected to decrease to 1,144,000 by 1980 (Bureau of Economic Analysis, 1974, 1977). MX employment would be about 0.2 percent of either historic or projected employment levels.

- The EIFS economic base multiplier projects that MX contracting in the region would generate about 2,091 jobs. The EIFS employment estimate is about 11 percent lower than the RIMS estimate. Together, these two models estimate the general range of employment effects that could result from MX contracting.
- MX will stimulate a modest number of additional jobs in the state. Even though the current employment base is relatively small, effects will not be strongly felt.

MX-Related Changes in Earnings

- Annual earnings resulting from initial investment by the Air Force are estimated to be:

Direct Earnings	$11.5 million
Indirect-Induced Earnings	$15.3 million
Total Earnings	$26.8 million

- The increase in earnings is greater than the initial expenditures by the Air Force.
- Current (1975) state earnings totaled $13.4 billion and are projected to increase to $17.5 billion by 1980 (Bureau of Economic Analysis, 1974, 1977).
- The maximum reasonable annual investment level represents 0.1 percent of both 1975 and 1980 projected earnings levels.
- MX will produce moderate increases in earnings. These investment levels should prove both beneficial and acceptable.
- Workers in directly affected industries will get about 43 percent of local MX-induced earnings; 57 percent will be distributed throughout the state's economy.
- Workers in directly affected industries will earn about $18,500 per year, while workers in other industries affected by MX will average about $8,800 per year.

Population and Housing

- MX-created employment may induce 500 to 600 persons to inmigrate to Colorado. This includes 240 workers plus their families. Most MX-related jobs will be filled by locally available workers.
- Statewide housing demand will increase by approximately 240 units. The state's largest metropolitan area, where most aerospace and support employment is located, is currently characterized by limited vacant housing units.

Full-scale development housing impacts will aggravate this situation to a limited extent.

Energy Impacts. At the rate of 1.2 kWh for each dollar of aerospace industry output, and with an expected \$85 million to \$119 million output in Colorado, aerospace electric requirements will total about 102 million to 168 million kWh. When it is considered that the project will last 57 months, an average 12-month requirement would be equal to about 0.1 percent of Colorado's 1975 production of electricity. Project-related population migration into Colorado could increase domestic needs by approximately 2.0 million kWh per year.

Because Colorado is an energy-rich state, exporting electricity and coal, the project should have little or no negative effect on the state's energy environment.

Air Quality Impacts. Within the representative metropolitan Colorado production area, the air quality exceeds national air quality standards up to 2.3 percent of the time, depending on the pollutant. The average per capita concentration of ozone, the pollutant most frequently exceeding standards, is 1.95×10^{-4} $\mu g/m^3$/per person. For the estimated potential population increase of 600 people associated with the MX program, the maximum projected ozone increase of 0.12 $\mu g/m^3$ is not a significant impact on the area's air quality. The other pollutants (carbon monoxide, sulfur dioxide, nitrogen oxides, and particulates), which rarely exceed standards, have a much lower impact potential.

Water Impacts. At the rate of 1 acre-ft (1,233.5 m^3) of water per million dollars of aerospace sales, Colorado's \$85 million to \$119 million share of the project will require about 85 acre-ft to 119 acre-ft (10×10^4 m^3 to 1.5×10^5 m^3) of water over a 57-month period. Except for some water quality problems in the South Platte River Basin, in the northeastern part of the state, Colorado has no water quantity or quality problems, and therefore should be able to accommodate the requirements of the project without adverse effect on the water environment. Water requirements of the induced population depend on the accuracy of the population growth estimates. In general, 1 acre-ft (1,233.5 m^3) of water will supply five people for a year. Assuming each MX job migrant has a family of 2.5 people, each 100 MX jobs that induce population growth will require an additional 50 acre-ft (6.1×10^4 m^3) of water. Excepting localized areas, Colorado has sufficient water to support this growth.

Utah. Utah's share of aerospace and support industry employment was 1.4 percent of the nation's 1972 total. If national MX investments range from \$5 billion to \$7 billion, Utah's share would equal from

$70 million to $98 million totally, and on an annual basis, from $14 million to $21 million.

MX-Related Changes in Gross Output

- The state's total output will increase by $198.9 million to $278.4 million. Annually, output increases by $39.8 million to $59.7 million.
- State industries receiving a large direct stimulus include: Other Transportation Vehicles; Ordnance and Accessories; Miscellaneous Business Services; Retail Trade; and Electrical Machinery, in that order.
- Effects on total output (direct and indirect-induced) will be concentrated in: Ordnance and Accessories; Food and Kindred Products; Other Transportation Vehicles; Real Estate and Combination; and Wholesale Trade.

MX-Related Changes in Number of Jobs

- Employment, resulting from the initial investment by the Air Force, is estimated to be:

Direct Employment	550 jobs
Indirect-Induced Employment	1,550 jobs
Total Employment	2,100 jobs

- Current (1975) state employment is 497,500, but this is projected to decrease to 479,100 by 1980 (Bureau of Economic Analysis, 1974, 1977). MX employment would be about 0.4 percent of either historic or projected employment levels.
- The EIFS economic base multiplier projects that MX contracting in the state would generate about 1,700 jobs. The EIFS employment estimate is about 20 percent lower than the RIMS estimate. Together, these two models estimate the general range of employment effects that could result from MX contracting.
- MX could generate a modest number of new jobs in Utah, which could offset the projected loss and thus prove even more beneficial. Thus, projected investment levels would be acceptable.

MX-Related Changes in Earnings

- Earnings resulting from the initial investment by the Air Force are estimated to be:

Direct Earnings	\$ 9.5 million
Indirect-Induced Earnings	\$11.7 million
Total Earnings	\$21.2 million

- The increase in earnings is more than the initial expenditures by the Air Force.
- Current (1975) regional earnings totaled \$5.2 billion and are projected to increase to \$6.8 billion by 1980 (Bureau of Economic Analysis, 1974, 1977).
- The maximum reasonable annual investment level represents 0.4 percent of 1975 levels and 0.3 percent of projected 1980 levels.
- Earnings increases related to MX are modest, even considering the limited existing economic base of Utah. Projected investment levels would be both acceptable and beneficial.
- Workers in directly affected industries will get about 45 percent of total MX-induced earnings; 55 percent will be distributed throughout the regional economy.
- Workers in directly affected industries will earn about \$17,500 per year, while workers in other industries affected by MX will average about \$7,700 per year.

Population and Housing

- MX-created employment may induce 500 to 600 persons to in-migrate to Utah. This includes 220 workers plus their families. Other MX-related jobs will be filled by locally available workers.
- Statewide housing demand will increase by approximately 220 units. The state's largest metropolitan area, where most aerospace and support employment is located, is currently characterized by limited vacant housing units. Full-scale development housing impacts will aggravate this situation.

Energy Impacts. At the rate of 1.2 kWh for each dollar of aerospace industry output, and with an expected \$70 million to \$98 million output in Utah, project-related aerospace requirements there will be about 84 million to 118 million kWh. This is equal to a little over 0.1 percent of the 1975 production of electricity in Utah, and will be spread over the 57-month period of this project. Limited population migration into Utah could increase electricity demand by 2 million kWh per year.

Air Quality Impacts. As a result of relatively large pollution sources and poor dispersion conditions, there is an air quality problem in the general vicinity of the main urbanized area of Utah, where particulates

and ozone now exceed standards. The level of pollutants per capita is also higher here than in other regions. MX-related employment would add small increments to the levels of all pollutants and would increase the probability of exceeding nitrogen oxide, ozone, and particulates limits. Additional population in nearly any location tends to aggravate existing conditions, and the relative potential for air quality impacts therefore, is greater in this area, where an air quality problem exists, than in other urban areas in the nation.

Water Impacts. At the rate of 1 acre-ft (1,233.5 m^3) per million dollars of aerospace output, and with \$70 million to \$98 million proposed to be spent in Utah, 70 acre-ft to 98 acre-ft (8.6×10^4 m^3 1.2×10^5 m^3) of water will be required by the aerospace industry for the project over a 57-month period. Water requirements of the induced population depend on the accuracy of the population growth estimates. In general, 1 acre-ft (1,233.5 m^3) of water will supply five people for a year. Assuming each MX job migrant has a family of 2.5 people, each 100 MX jobs that induce population growth will require an additional 50 acre-ft (6.1×10^4 m^3) of water. Because of the state's adequate and good quality water, the project should not have a detrimental effect on the state's water environment.

Massachusetts. Massachusetts' share of aerospace and support industry employment was only 0.4 percent of the nation's 1972 total. If national MX investments range from \$5 billion to \$7 billion, Massachusetts' share would equal from \$20 million to \$28 million totally, and on an annual basis, from \$4 million to \$6 million.

MX-Related Changes in Gross Output

- The Massachusetts' total output will increase by \$70.7 million to \$90.0 million. Annually, output increases range from \$14.1 million to \$21.2 million.
- State industries receiving a large direct stimulus include: Other Transportation Vehicles; Electrical Machinery; Miscellaneous Business Services; Ordnance and Accessories; Retail Trade; and Communications, in that order.

MX-Related Changes in Number of Jobs

- Employment, resulting from the initial investment by the Air Force, is estimated to be:

Direct Employment	200 jobs
Indirect-Induced Employment	500 jobs
Total Employment	700 jobs

- Current (1975) state employment is 2.5 million people, and this is projected to increase to 2.9 million by 1980 (Bureau of Economic Analysis, 1974, 1977). MX will not appreciably alter these totals.

- The EIFS economic base multiplier projects that MX contracting in the region would generate about 600 jobs. The EIFS employment estimate is about 18 percent lower than the RIMS estimate. Together, these two models estimate the general range of employment effects that could result from MX contracting.

- MX will generate large employment effects, but the large base of current employment means MX-related changes will be acceptable within the region.

MX-Related Changes in Earnings

- Earnings, resulting from the initial investment by the Air Force, are estimated to be:

Direct Earnings	$2.7 million
Indirect-Induced Earnings	$4.6 million
Total Earnings	$7.3 million

- The increase in earnings is more than the initial expenditures by the Air Force.

- Current (1975) state earnings totaled $29.1 billion and are projected to increase to $45.7 billion by 1980 (Bureau of Economic Analysis, 1974, 1977). MX will not noticeably increase these levels.

- The total increase in earnings resulting from MX is small, and would surely be acceptable within the state.

- Workers in directly affected industries will get about 37 percent of total MX-induced earnings; 63 percent will be distributed throughout the state's economy.

- Workers in directly affected industries will earn about $17,600 per year while workers in other industries affected by MX will average about $8,900 per year.

Population and Housing

- MX-created employment may induce 100 to 200 persons to in-migrate to Massachusetts. This includes 80 workers plus their families. Other MX-related jobs will be filled by locally available workers.

- Statewide housing demand will increase by approximately 80 units. The state's largest metropolitan area, where most aerospace and support employment is located, is currently characterized by a

relatively large amount of vacant housing units. Full-scale development housing impacts will be negligible, except on a very localized level.

Energy Impacts. At the rate of 1.2 kWh of electric energy required for each dollar of aerospace industry output, and with an expected \$20 million to \$28 million aerospace output, there will be a requirement for 24 million to 28 million kWh over a 57-month period. This is equal to less than 0.1 percent of the state's 1975 production of electricity. Potential population migration into Massachusetts could require approximately 700,000 kWh additional energy per year.

Air Quality Impacts. The potential impact on air quality of an additional 200 people in the Boston area is negligible. The present per capita pollution levels are small, ranging from 2.0×10^{-3} $\mu g/m^3$/person for carbon monoxide to 1.6×10^{-5} $\mu g/m^3$/person for ozone. Although ozone air quality limits are exceeded about 2 to 3 percent of the time, the additional potential for exceeding the limits from MX-related employment is insignificant.

Water Impacts. At the rate of 1 acre-ft (1,233.5 m^3) of water per million dollars of aerospace expenditure, and with \$20 million to \$28 million proposed to be spent in Massachusetts, only 20 acre-ft to 28 acre-ft (2.5×10^4 m^3 to 3.5×10^4 m^3) of water will be required over the 57 months of the project period. Although the water requirements of the induced population cannot be calculated, the Massachusetts water supply will be quite adequate for the next 20 years, and therefore no adverse effects should be expected from the project for the state's water environment.

New York/New Jersey/Connecticut. This region's share of aerospace and support industry employment was 14.3 percent of the nation's 1972 total. If national MX investments range from \$5 billion to \$7 billion, the region's share would equal from \$715 million to \$1,001 million totally, and on an annual basis, from \$143 million to \$214.5 million.

MX-Related Changes in Gross Output

- The region's total output will increase by \$2,840.0 million to \$3,976.0 million. Annually, output increases by \$568.0 million to \$852.0 million.
- Regional industries receiving a large direct stimulus include: Other Transportation Vehicles; Electrical Machinery; Miscellaneous Business Services; Ordnance and Accessories; Retail Trade; and Machinery, except Electrical, in that order.

- Effects on total output (direct and indirect-induced) will be concentrated in: Ordnance and Accessories; Retail Trade; Other Transportation Vehicles; and Food and Kindred Products, in that order.

MX-Related Changes in Number of Jobs

- Employment, resulting from each million dollars of initial investment by the Air Force, is estimated to be:

Direct Employment	5,600 jobs
Indirect-Induced Employment	15,300 jobs
Total Employment	20,900 jobs

- Current (1975) regional employment is 12.0 million, and this is projected to increase to 13.8 million persons by 1980 (Bureau of Economic Analysis, 1974, 1977). MX employment would be about 0.1 percent of either historic or projected employment levels.
- The EIFS economic base multiplier projects that MX contracting in the region would generate about 10,500 jobs. The EIFS employment estimate is about 21 percent lower than the RIMS estimate. Together, these two models estimate the general range of employment effects that could result from MX contracting.
- Although a large number of jobs would be generated by MX contracting, the current base is so large that the increases would be acceptable and beneficial.

MX-Related Changes in Earnings

- Annual earnings, resulting from initial investment by the Air Force, are estimated to be:

Direct Earnings	$97.3 million
Indirect-Induced Earnings	$191.9 million
Total Earnings	$289.2 million

- The increase in earnings is more than the initial expenditures by the Air Force.
- Current (1975) regional earnings totaled $156.5 billion and are projected to increase to $244.2 billion by 1980 (Bureau of Economic Analysis, 1974, 1977). MX will not noticeably change these earnings levels.
- Large absolute increases in earnings from MX would occur in the region, but because it also has one of the largest existing economic bases, the effects would be acceptable and beneficial.

- Workers in directly affected industries will get about 34 percent of total MX-induced earnings; 66 percent will be distributed throughout the state economy.
- Workers in directly affected industries will earn about $17,400 per year, while workers in other industries affected by MX will average about $12,500 per year.

Population and Housing

- MX-created employment may induce up to 5,600 persons to in-migrate to the region. This includes 2,240 workers plus their families. Other MX-related jobs will be filled by locally available workers.
- Regional housing demand will increase by approximately 2,240 units. The region's largest metropolitan area, where most aerospace and support employment is located, is currently characterized by many vacant housing units. Full-scale development housing impacts will be negligible, except on a very localized level.

Energy Impacts. At the rate of 1.2 kWh for each dollar of aerospace industry output, and with an expected $715 million to $1,001 million output in the region, project-related aerospace requirements there will be about 858 million to 1,200 million kWh. This is equal to about 0.5 to 0.7 percent of the 1975 production of electricity in the region, and will be spread over the 57-month period of the project. New York/New Jersey/Connecticut potential growth increased energy demand could reach 12 million kWh per year.

Air Quality Impacts. The projected air quality impact in the New York/New Jersey/Connecticut metropolitan area due to an induced population growth of up to 5,600 people is negligible. The primary pollutant of concern in the region is ozone. Currently ozone limits are exceeded about 4 percent of the time when levels reach 3 to 4 times the allowable concentrations. The MX-induced population will produce less than a 1.0 percent increase in average ozone levels. The maximum effect of other pollutants concentrations (TSP, NO_x, and CO) from this population increase is estimated to be about 0.3 to 0.1 percent concentration increase.

Water Impacts. At the rate of 1 acre-ft (1,233.5 m^3) per million dollars of aerospace output, and with $715 million to $1,001 million proposed to be spent in the region, 715 acre-ft to 1,000 acre-ft (8.8×10^5 m^3 to 1.2×10^6 m^3) of water will be required by the aerospace industry for the project over a 57-month period. Water requirements

of the induced population depend on the accuracy of the population growth estimates. In general, 1 acre-ft (1,233.5 m^3) of water will supply five people for a year. Assuming each MX job migrant has a family of 2.5 people, each 100 MX jobs that induce population growth will require an additional 50 acre-ft (6.1×10^4 m^3) of water. Because of the region's generally adequate and good quality water, the project should not have a detrimental effect on the region's water environment.

Texas. Texas' share of aerospace and support industry employment was 2.2 percent of the nation's 1972 total. If national MX investments range from $5 billion to $7 billion, Texas' share would equal from $110 million to $154 million totally, and on an annual basis, from $22 million to $33 million.

MX-Related Changes in Gross Output

- The state's total output will increase by $388.9 million to $544.4 million. Annually, output increases range from $77.6 million to $116.7 million.
- State industries receiving a large direct stimulus include: Other Transportation Vehicles; Electrical Machinery; Miscellaneous Business Services; and Communications.
- Effects on total output (direct and indirect-induced) will be concentrated in: Ordnance and Accessories; Other Transportation Vehicles; Food and Kindred Products; Real Estate and Combinations; and Apparel and Other Fabricated Textile Products, in that order.

MX-Related Changes in Number of Jobs

- Employment, resulting from the initial investment by the Air Force, is estimated to be:

Direct Employment	900 jobs
Indirect-Induced Employment	2,500 jobs
Total Employment	3,400 jobs

- Current (1975) regional employment is 5.5 million, but this is projected to decrease to 5.2 million by 1980 (Bureau of Economic Analysis, 1974, 1977). MX employment would be about 0.1 percent of either historic or projected employment levels.
- The EIFS economic base multiplier projects that MX contracting in the region would generate about 3,200 jobs. The EIFS employment estimate is about 8 percent lower than the RIMS estimate. Together, these two models estimate the general range of employment effects that could result from MX contracting.

- MX could produce a modest increase in jobs and because of the large base of current employment in the state, this change would be acceptable.

MX-Related Changes in Earnings

- Annual earnings, resulting from the initial investment by the Air Force, are estimated to be:

Direct Earnings	$14.8 million
Indirect-Induced Earnings	$25.3 million
Total Earnings	$40.1 million

- The increase in earnings is more than the initial expenditures by the Air Force.
- Current (1975) earnings totaled $59.6 billion and are projected to increase to $75.9 billion by 1980 (Bureau of Economic Analysis, 1974, 1977).
- The maximum reasonable annual investment level in Texas represents 0.1 percent of both 1975 and 1980 projected earnings levels.
- MX will generate a modest amount of additional earnings in the state, and since the existing base is large, project effects will be beneficial and acceptable.
- Workers in directly affected industries will get about 37 percent of total MX-induced earnings; 63 percent will be distributed throughout the state's economy.
- Workers in directly affected industries will earn about $16,500 per year, while workers in other industries affected by MX will average about $9,900 per year.

Population and Housing

- MX-created employment may induce 800 to 900 persons to in-migrate to Texas. This includes 360 workers plus their families. Other MX-related jobs will be filled by locally available workers.
- Statewide housing demand will increase by approximately 360 units. The state's largest metropolitan area, where most aerospace and support employment is located, is currently characterized by many vacant housing units. Full-scale development housing impacts will be negligible, except on a very localized level.

Energy Impacts. At the rate of 1.2 kWh for each dollar of aerospace industry output, and with an expected $110 million to $154 million output in Texas, project-related aerospace requirements there will be about

132 million to 185 million kWh. This is equal to about 0.1 percent of the 1975 production of electricity in Texas, and will be spread over the 57-month period of this project. Population migration into Texas could increase electrical energy demand by a maximum of 3 million kWh per year.

Air Quality Impacts. In metropolitan areas of Texas, fine particle emissions and the addition of precursor emissions that could increase photochemical ozone have the greatest potential for affecting air quality. Particulate concentrations could increase between 0.1 and 0.3 percent and for ozone slightly over 0.3 percent on the average. Ozone levels currently exceed national limits about 3 percent of the time. Should all MX-related 900 jobs in the state be filled by in-migration into one urban area, the number of days on which ozone levels exceed standards could increase.

Water Impacts. At the rate of 1 acre-ft (1,233.5 m^3) per million dollars of aerospace output, and with \$110 million to \$154 million proposed to be spent in Texas, 110 acre-ft to 154 acre-ft (1.3×10^5 m^3 to 1.8×10^5 m^3) of water will be required by the aerospace industry for the project over a 57-month period. Water requirements of the induced population depend on the accuracy of the population growth estimates. In general, 1 acre-ft (1,233.5 m^3) of water will supply five people for a year. Assuming each MX job migrant has a family of 2.5 people, each 100 MX jobs that induces population growth will require an additional 50 acre-ft (6.1×10^4 m^3) of water. Because of the state's adequate and good quality water, the project should not have a detrimental effect on the state's water environment.

3.4 TEST PROGRAM IMPACTS

Four test sites have been identified to date (See Table I-1). Impacts anticipated at Vandenberg AFB are the subject of Volume III of this report. Impacts at Arnold AFS, Edwards AFB, and Kirtland AFB are discussed below.

Arnold Air Force Station (3.4.1)

Specifics of the Arnold Engineering Development Center test facilities and operations are described in the Formal Environmental Assessment for Arnold Engineering Development Center Operations, Arnold Air Force Station, Tennessee, Air Force Systems Command prepared in accordance with AFR 19-2 in compliance with the National Environmental Policy Act of 1969, revised in February of 1977. Testing for the MX weapons system development would constitute only a small portion of the total testing accomplished at the Arnold Center.

The environmental impacts of station operation generally relate to air quality, water quality, and noise. Emissions to the atmosphere from support facilities include nitrogen oxide, particulates, carbon monoxide, hydrocarbons, sulfur oxides, freon, and ethylene glycol. Emissions also result from the combustion of jet and rocket fuels. In most cases, these products are processed through cooler-scrubbers prior to release from exhaust stacks. Measurements have shown that the instantaneous ground level concentrations were safe and that the established air quality standards were met (rocket motor emissions are more fully discussed in Section 3.4.4).

Water quality is protected according to the terms of an NPDES permit. Cooling water is returned directly to the Woods Reservoir, but where water has been contaminated, it is diverted to the retention reservoir for settling or skimming prior to return to the Woods Reservoir. A storm sewer system picks up drainage from floor areas, streets, parking, and yard facilities and this water is treated in skimming ponds before discharge to two of the tributaries to the Woods Reservoir. All discharges meet NPDES requirements.

Noise levels as a result of testing within insulated buildings or low-pressure chambers are minimal. Some rocket tests are conducted at a ground level test stand and high transient noise levels result. Ear protection is required in controlled access areas where decibel levels might otherwise inflict damage. All predicted noise levels at the facility boundary would be of a low enough intensity and short enough duration that OSHA regulations would be met. The buffer zones which have been maintained between the test facilities and the boundary of the Air Force station have been planted with evergreen vegetation in order to help reduce noise levels outside of the complex. The environmental assessment for the Arnold Engineering Development Center states that there have been no complaints from the family housing area, the surrounding communities, or areas bordering the reservation. Therefore, the noise levels existing at the reservation boundary are considered to be sufficiently low that no irritation is caused.

Testing of the MX system at the Arnold Engineering Development Center will constitute a continuation of operations similar to those which have been conducted at Arnold in the past. For further specifics, the reader should consult the Formal Environmental Assessment referenced above.

<u>Edwards Air Force Base</u> (3.4.2)

The environmental impacts of destruct tests at Edwards AFB are expected to be minimal. Emissions to the atmosphere will be primarily those from the explosives, and from combustion of the liquid propellants of Stage IV to the extent that the fuel detonates during the test. Other emissions will consist of particulates generated by the materials exploded and by dust raised during the testing. No toxic substances or materials adversely affecting air quality are released during the combustion of Stage IV fuel. All emissions will be of a transient, highly localized nature and will be in quantities sufficiently small that effects will be unnoticeable outside the test area boundaries.

There should be no adverse impacts of destruct tests on water quality. No surface water features exist in the immediate vicinity of testing sites except during infrequent storms. Fragments which are dispersed as the result of detonations will be collected and examined as a portion of the testing program and either recycled or disposed of in the solid waste disposal area.

Noise levels as a result of destruct tests are expected to be considerably below levels generated by major rocket engine tests because large quantities of propellants will not be detonated. Personnel involved in the testing program will be protected in block houses during detonations. Sound pressure levels and decibel levels will be sufficiently low so that no annoyance or physiological damage will result in unrestricted areas either on or off base.

The quantity/hazard distance tests will be conducted during FY 1978-1979. The program will take place over a 4-month period and will include a total of at least 32 detonations ranging in size from 8 to 16,000 lb (3.6 to 7,260 kg) of TNT. There will be 25 tests each using 8 lb (3.6 kg) of TNT, 4 tests each using 18 lb (8.2 kg) of pentolite, 2 tests each using 1,000 lb (453.6 kg) of TNT, and 1 test using 8,000 lb (3,629 kg) of a class 1.1 propellant which is expected to be equal to 16,000 lb (7,260 kg) of TNT.

The combustion products and weight percentage resulting from detonations of TNT, pentolite, and the class 1.1 propellant are given in Table 3-8. The total quantity of exhaust species resulting from the largest detonation will be less than that generated by a typical firing of a large rocket motor. Such firings have been conducted in the past and it is known that hazardous conditions from toxic gases will not extend beyond the Rocket Propulsion Laboratory boundaries (Reed, 1978).

Overpressures and noise levels associated with the largest detonation were examined in the environmental assessment (Reed, 1978). An overpressure of 0.5 psi, which would be sufficient to cause broken windows, would extend approximately 1,900 ft (580 m) from the point of detonation. This is well within the restricted area and no facilities that could be damaged by the detonation are within this area. It is anticipated that the overpressure in the community of Boron which is 4.7 mi (7.5 km) from the point of detonation would be less than 0.01 psi. This sound pressure would have no adverse impact on structural features in the community and would be associated with a noise level similar to that of a sonic boom. Since only one large detonation test is planned, and the associated noise impacts would be similar to those experienced as a result of frequent test flights in the area, adverse impacts in surrounding areas are expected to be minimal.

Meteorological conditions which could result in the effect termed "weather focusing" will be avoided during larger detonation tests. Weather focusing occurs when local weather patterns influence the conduction of sound such that overpressures well above theoretical levels result in localized areas. A program currently underway will permit prediction of meteorological focusing conditions, potential impacts locations, and magnitude of effects so that adverse situations can be avoided (Reed, 1978).

The conclusion of the environmental assessment about the quantity/hazard detonation tests is that the program is not expected to create any adverse conditions or cause a significant environmental impact.

Several rocket motor tests will be conducted at the Rocket Propulsion Laboratory at Edwards in support of the MX program. These tests will utilize reusable motors which have been developed by the Rocket Propulsion Laboratories in order to achieve significant costs savings. The Rocket Propulsion Laboratory's super hippo motor will be used to demonstrate

Table 3-8. The combustion products and weight percentage resulting from the detonation tests.

COMBUSTION PRODUCT	TNT	PENTOLITE	CLASS 1.1 PROPELLANTS
CO	26.3	25.8	36
CO_2	29.9	14.8	
H_2	0.01	0.4	1
H_2O	6.1	21.4	2
N_2	14.0	25.2	12
NH_3	1.87	3.5	
HCN	5.4		
C	1.2		
CH_4	3.5	0.5	
CH_3OH		4.1	
CH_2O_2		1.4	
Al_2O_3			33

Source: Reed, 1978.

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advanced movable nozzle technology applicable to any final selection of an MX first stage. Tests will be conducted using both the short length super hippo and the extended length super hippo. A smaller single cartridge loaded, heavy weight reusable motor known as the CHAR motor will be used in testing related to the third stage motor program. Tests were scheduled for May, July, and September of 1978 and February, October, and November of 1979. The largest tests will be those of the extended length super hippo motor which will burn approximately 89,000 lb (40,000 kg) of propellant as opposed to 20,000 lb (9,100 kg) for the short length super hippo motor tests. Only two firings of the extended version of the super hippo will be used in the MX advanced nozzle and thrust vector control development firings. All tests will be of approximately 60 seconds duration and will generate 30,000 lb (13,600 kg) of particulate emissions. In addition, 15,000 lb (6,800 kg) of HCl and 14,000 lb (6,350 kg) of CO will be released to the atmosphere. These large tests will be conducted in test area 1-56 known as Haystack Butte.

Theoretical modeling and past experience indicate that for all atmospheric conditions under which a test firing might occur, HCl concentrations at the reservation boundary are below all exposure criteria. Within the reservation, adequate measures are taken so that all personnel are cleared from potentially hazardous areas. Carbon monoxide is also a

hazardous gas emitted during solid rocket fuel burns. However, under the extremely hot exhaust gas conditions, carbon monoxide is oxidized with atmospheric oxygen to carbon dioxide. Carbon monoxide concentrations within the exhaust plume are at or below atmospheric concentrations. Aluminum oxide particulates ranging in size from 0.1 to 250 microns will also be emitted during solid rocket fuel burns. The environmental assessment concludes that the number of frequency of test firings will not cause ambient aluminum oxide particulate concentrations to increase by any detectable amount (Reed, 1978).

Testing of the extended super hippo results in the worst-case noise conditions from operation of the Rocket Propulsion Laboratory. During testing, all test area personnel are restricted to block houses which provide adequate protection from rocket engine noise. The administrative and shop facilities of the Rocket Propulsion Laboratory are protected from test site acoustical impacts by topographical features which significantly reduce noise levels to a point where no physiological damage would result from 60 second exposure.

Noise levels resulting from testing of the extended super hippo motor will not be completely attenuated within the reservation boundary. However, none of the noise levels at the boundary would be sufficient to cause physiological damage, and annoyance impacts are minimized by the fact that most areas adjacent to the reservation are remote and inaccessible. The town of Boron to the north of the test site could receive decibel levels in the range of approximately 80 dbA. This is approximately equivalent to the noise level which would be experienced by the operator of a large power lawn mower. The fact that there would be only two tests of the extended super hippo rocket engine, each with a duration of approximately 60 seconds, indicates that there will be relatively little annoyance to surrounding communities as a result of the MX rocket engine testing program.

Further details of the Rocket Propulsion Laboratory test facilities and of the calculations for assessment of potential impacts of emissions and noise levels are given in the *Draft Environmental Assessment Air Force Rocket Propulsion Laboratory* (Reed, 1978).

Kirtland Air Force Base (3.4.3)

The EMP tests scheduled for Kirtland AFB will use existing simulators known as the HPD (horizontally polarized dipole) and VPD (vertically polarized dipole). Another simulator known as the "trestle," and presently under construction, may also be used in MX testing. All EMP test sites at Kirtland are in remote areas isolated from electronic equipment which otherwise might be adversely affected by the tests. High voltage equipment dissociated with the EMP simulators is protected according to usual safety precautions, and test personnel operate under OSHA and special biomedical EMI regulations. Environmental evaluations

of construction and operation have been prepared for the HPD, VPD and trestle facilities, and no significant adverse environmental impacts are expected.

Rocket Motor Test Program (3.4.4)

MX motor development at both Edwards and Arnold are not expected to reveal any large departures from previous Air Force development programs. The manufacture of solid rocket motors of the approximate size of the MX grains and larger (up to 22 ft or 6.7 m in diameter) is a well understood process that has been carried on successfully for many years. The use of additives to the basic propellant to produce desired thrust characteristics is a developed stage of technology, as is the determination of the type and size of motor grain.

The operational criteria of the system are used to determine the number of test firings required to satisfy performance specifications and these firings are normally conducted during the motor manufacturing cycle. Instrumented static test firings may be done at the manufacturers own facility or at an Air Force test center. If high altitude performance tests are required for any reason these are normally conducted in the high altitude chambers at the Air Force's own Arnold Engineering Center near Tullahoma, Tennessee. Static test firings are conducted routinely at the Air Force Rocket Propulsion Laboratory at Edwards AFB, California for both advanced development programs and product improvement programs for existing or planned systems.

Solid propellants are designed to burn under controlled conditions to produce hot gases that are released through a nozzle into the atmosphere. The propellant mix consists of either fuel and an oxidizer, that do not react below some minimal temperature, or compounds such as nitroglycerin and nitrocellulose that combine fuel and oxidizer in a single molecule. The mixes with separate fuel and oxidizer compounds are composite propellants, while the nitroglycerin-nitrocellulose propellants are identified as "double-base" types.

The composite propellants are normally made up of a fuel-binder with small particles of the oxidizer material distributed throughout the mix. The most common form of this propellant is one containing polyurethane and 70 to 80 percent by weight of ammonium perchlorate; the ammonium perchlorate being the oxidizer. This propellant produces hydrogen chloride gas as one of its exhaust constituents and, if aluminum is used as a fuel additive to improve thrust (a common practice), aluminum oxide is also released to the atmosphere. Although these propellants are less energetic than the double-base type, they are used for the larger lower-stage grain sizes because they are much less sensitive to shock and are easier to transport. The lower stages of the MX vehicle use this propellant and manufacturer's test firings will result in typical exhaust emissions as listed in Table 3-9.

Table 3-9. Weight fractions in percent for a typical composite rocket exhaust.

EXHAUST COMPONENT	WEIGHT PERCENT
Al_2O_3	30.20
CO	24.17
HCl	20.93
H_2O	9.43
N_2	8.74
CO_2	3.44
H_2	2.08
Cl	0.29
$FeCl_2$	0.59

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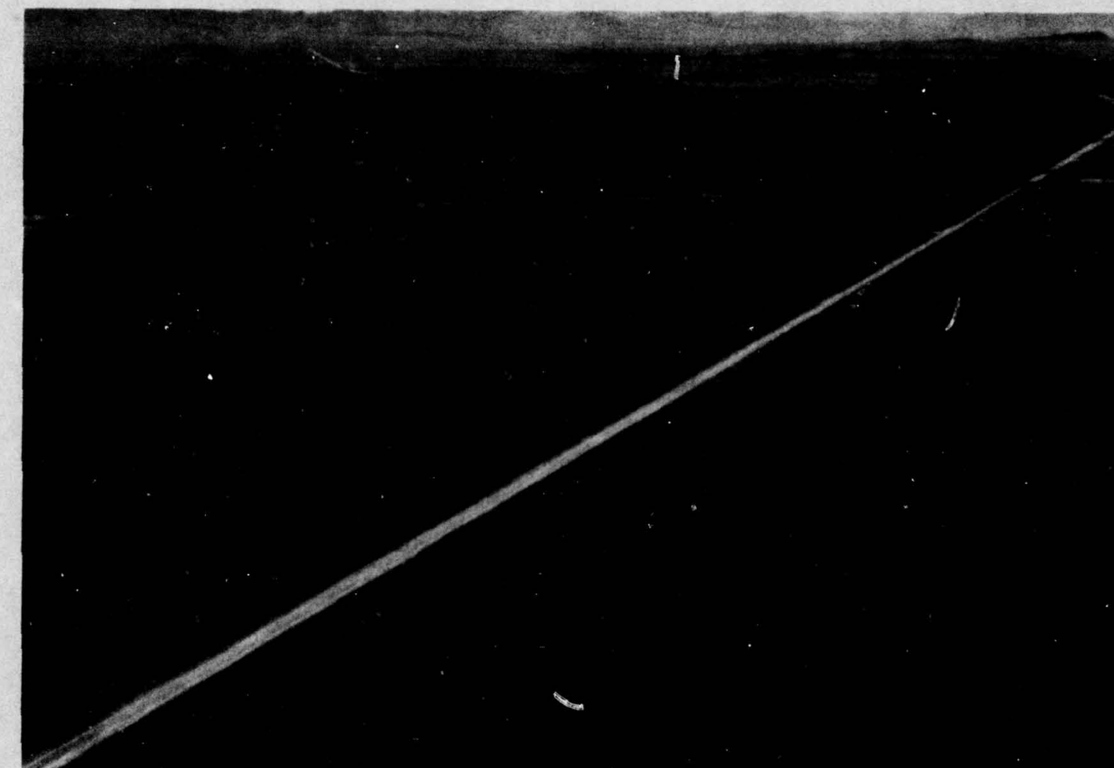
Source: U.S. Department of the Air Firce, 1977a.

These are gaseous emissions at the exit plane of the nozzle. Changes occur with distance from the nozzle as cooling occurs so that the aluminum oxide (Al_2O_3) becomes a powdery solid, CO converts to CO_2, HCl forms as a vapor and possibly a condensed liquid and the other gases react of combine to form varying trace compounds. In small motors, little effect on surroundings or the atmosphere is seen. For solid motors the size of those proposed for the MX system, some precautions to prevent exposure of people to the exhaust are required. By the time the cloud of exhaust material has risen (due to its high temperature), cooled and traveled a few thousand ft (1,500 m) under nominal mixing conditions in the atmosphere, pollutant concentrations near the ground are reduced to levels compatible with published safety and public welfare standards. The element of primary concern from the exhaust constituent list is hydrogen chloride (HCl) which is toxic and corrosive at moderate concentrations.

Provisions for ensuring a sufficiently remote test location are an integral part of the MX motor production schedule. Only a few firings of the MX motor stages will be required as the propellant is not expected to be one with a high technical risk. Most composite solid propellant formulations are known and the test program would only be required to demonstrate hardware integrity with specific MX components. Less than five tests are normally required for this, although more may be planned for contingency or other purposes.

Double-base propellants are used in the upper stage of the MX vehicle. Testing of these motors does not result in as substantial an amount of HCl in the exhaust stream as in the composite propellant firings. Only a small percentage of HCl is contained in the exhausts from these motors and normally it is not detectable any distance from the nozzle. Test conditions based on the potential explosive hazard of this type of propellant are of more concern than the low possibility of a toxic hazard. If a combined double-base/composite propellant is investigated for possible upper stage use in the MX vehicle, exhaust constituents similar to those from composite propellants used alone will be generated.

Although most test firings are conducted on horizontal, fixed test installations instrumented to verify the performance of the motor, the exhaust clouds rise rapidly due to their high temperature. The high velocities with which the gases enter the atmosphere create turbulence which enhances atmospheric mixing and cooling effects. The result after a few minutes is a cooled mass of exhaust components moving with local wind flow and continuing to be diluted by the normal eddying and mixing of the wind. Differences in terrain, local meteorology and the test schedule itself (i.e., time of day, season, etc.) will cause different test locations to have dissimilar pollution effects for very similar motors.



Alternatives

4
ALTERNATIVES TO THE PROPOSED ACTION

4.1 INTRODUCTION

The proposed action analyzed in this volume is full-scale engineering development of a land-based ICBM capable of deployment in mobile basing, along with hardware and support systems. Alternatives to the proposed action fall into three categories necessary to support an ICBM in a mobile basing mode.

- No project
- Development and modification of existing systems
- Alternative development schedules

4.2 NO PROJECT

Under the No Project alternative, full-scale development of a mobile land-based missile system would not be implemented. The program would either proceed directly to production using untested engineering blueprints or would halt indefinitely. Should the program halt indefinitely, the United States would continue to rely upon current ICBM systems, and strategic imbalance could occur. Proceeding directly from engineering blueprints to production of operational missiles is unacceptable because reasonable assurances of system reliability would not be available and cost projections would be impossible.

4.3 DEVELOPMENT AND MODIFICATION OF EXISTING SYSTEMS

In lieu of developing an MX system in multiple aimpoint basing, existing systems, in particular, Minuteman III, could be modified to

provide some improvement in the survivability and effectiveness of the United States land-based missile force. Two main classes of alternatives are contained within this category: upgrade the current missile systems in their current silo deployment mode; or modify existing missiles (Minuteman) for deployment in the multiple aimpoint basing mode selected for full-scale engineering development (see Volume IV for a discussion of MX basing modes and their alternatives).

Upgrade Current Systems (4.3.1)

Improvements in the Minuteman III missile, although feasible, are reaching the limits of that system's capability. Propulsion improvements (e.g., a new second/third stage) would provide the capability to slightly increase the number of reentry vehicles each missile could carry. In addition, a new guidance system could be developed to improve the effectiveness of each reentry vehicle. These changes could result in some small increase in capability for each missile. However, even with the expenditure of several billions of dollars for these modifications, next to nothing could be done to redress the problem of the growing vulnerability of a silo based missile force in the 1980s.

Another option in the category of modifications to existing systems, is to increase the hardness of these systems so they would be more survivable under attack. A major silo hardness upgrade program is on-going and will soon be complete. This program significantly increases the hardness of MM III silos and provides a near term hedge against the rapidly growing threat. However, even with this increased hardness, the projected accuracy and number of Soviet ICBM weapons in the early to mid 1980s could seriously erode current silo survivability. Any further increase in silo hardness, although feasible, would be very costly and would provide only a marginal increase in expected survivability. Thus, the deterrent capability of the United States land-based missile force would still be projected to seriously erode in the early to mid 1980s.

Quantification of the environmental effects of these alternatives would require definitions of the scope of the improvement program, but generally they would be anticipated to be less than those of full scale development of MX.

Modify Current ICBMs (Minuteman III) for Multiple Aimpoint Deployment (4.3.2)

The current force of Minuteman missiles could be modified to operate in one of the multiple aimpoint basing modes being considered in this EIS. Modifications would be required to the missile structure, guidance and control system, deployment module and a gas ejection (cold launch)

system to eject the missile from a canister after it has been erected to the launch position. In order to maintain a sufficient retaliating capability after a preemptive Soviet attack on our ICBM force a larger number of Minuteman missiles and possibly more protective structures would have to be deployed as compared to MX. Thus, the total life cycle cost (including 10 years of operation, modifying, and deploying the Minuteman force in one of the mobile basing modes) would be greater than MX.

4.4 ALTERNATIVE DEPLOYMENT SCHEDULES

Impacts have been addressed in this FEIS in terms of a 4-year 9-month development schedule. Two scenarios have been used: one with annual expenditures of $1 billion, and the other with annual expenditures of $1.5 billion. The 4-year 9-month schedule is considered to be most realistic in terms of the technological complexity of achieving missile subsystem compatibility, performance, and reliability.

Over a modest range, shortening of the schedule could result in roughly linear changes in impact, which could be extrapolated between the annual values considered in the analysis. Changes in impacts would be relatively small. An accelerated FSED would presumably precede an accelerated production program process, in which such effects could be considerable.

Similarly, an extended full-scale development program would have a proportionately reduced concentration of environmental impacts, over reasonable limits. To the extent that full-scale development is delayed, either full-scale production or deployment will be delayed, or the production/deployment phase must be shortened to meet the contemplated schedule. A delay in the overall schedule, however, would potentially result in a period of time over which a strategic imbalance would either exist or be perceived to exist favoring the USSR, contrary to United States policy.

Unavoidable Adverse Effects

5
PROBABLE UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

5.1 PROBABLE ADVERSE ENVIRONMENTAL EFFECTS

State and Regional Level (5.1.1)

- Population. In states with industrial specialization in aerospace, new jobs will induce population growth. At the statewide level, in-migration ranging from California's 10,000 persons to a population increase of 200 persons in Massachusetts, will have negligible effect. Within each state, in-migration could affect those communities surrounding aerospace and support industries. Many metropolitan areas, particularly in the western states, have expressed concern regarding population growth, but population impacts from MX should be relatively minor when distributed within a metropolitan area.
- Water. Full-scale development would require large amounts of water used directly in aerospace industries, and indirectly by supporting industries and increased population. Current supply constraints could inhibit growth in parts of southern California, if FSED coincides with another drought. This cannot be predicted.
- Energy. Electric energy and fuels are important inputs in the affected manufacturing industries. Depending upon the sources of supply and the type of fuels used to produce electric energy in a given region, an increase in energy consumption due to MX would require increasing amounts of natural resources, such as oil, natural gas, coal, water, and nuclear materials.
- Air Quality. At aerospace and support industry locations and communities receiving increased population, air pollution levels could increase a minor amount. Increased traffic due to employment increases in the MX contractor plants and indirectly induced industries and services, and increased travel resulting from general population growth may have an additional minor impact on air quality.

Test Facility Level (5.1.2)

Those full-scale engineering development tests requiring highly specialized equipment will be conducted at Edwards AFB, Arnold AFS, and Kirtland AFB. Planned tests represent both a continuation, and a minor portion of ongoing activities. Thus, adverse environmental effects unique to full-scale engineering development are not expected.

5.2 MITIGATION MEASURES PROPOSED TO MINIMIZE POTENTIAL IMPACTS

State and Regional Level (5.2.1)

Mitigation measures within the control of the Air Force have been, and will continue to be, incorporated into the planning process. As potential impacts are identified, appropriate mitigation measures will be made an integral part of the planning process.

Impacts on manufacturing areas are a result of industrial activities and of induced population growth. This report is being distributed to governmental agencies as a mitigation to help them in their planning processes for new growth. In all areas, this growth is not expected to be significant. The MX program currently incorporates mitigation of potential impacts in its contracting process. Bidders are evaluated, in part, based on environmental awareness demonstrated in their proposals.

Test Facility Level (5.2.2)

Impacts in component testing areas represent an extension of ongoing testing programs unrelated to MX. The incremental impacts of MX are sufficiently small that no independent mitigations are proposed beyond those now incorporated in the operation of the test facilities.

Short-/Long-Term Productivity

6

RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND LONG-TERM PRODUCTIVITY

Development of a national defense system such as MX involves trade-offs among competing goals. Given that resource inputs are scarce, allocating them into full-scale engineering development implies foregoing alternative goods. Thus, the nation will incur costs as well as benefits. In addition to national defense considerations detailed in Volume I, employment may increase, payments to capital and labor may rise, and valuable research and technological improvements are likely. MX-induced benefits and costs will be experienced both nationally and regionally.

6.1 SHORT-TERM COSTS

Full-scale engineering development of the MX system will extend over a 4-year 9-month period. Costs that accrue as a result of this project will be relatively short term. In addition, since all design, development, and testing will occur in particular regional sectors of the nation, potential costs will accrue regionally. These costs would arise either because of increased production levels, or because of the altered mix of output within related industries. In addition, costs may occur as regional supplier industries expand. The following short-term environmental impacts could arise.

- Since the affected industries allocate their outputs toward MX goods, they would utilize factors of production which could otherwise be utilized elsewhere. For example, electrical or fossil fuel energy would be required. If not utilized on MX outputs, they could perhaps either be conserved or utilized elsewhere. These foregone alternative uses would be a regional cost.

- To the extent that regional output and, consequently, employment increases, there may be potential costs arising from additional congestion within affected industrial areas.

- There may occur slight decreases in regional air quality surrounding the affected industries. This would be expected if local contractors' work force increases are imported from other regions, with increased commuter traffic.
- To the extent that systems and/or component testing occurs in surrounding urbanized areas, there will be temporary increases in ambient noise levels.
- In addition to the extent regional employment increases, and assuming that some additional workers and their dependents will be imported from outside, impacts could result from population pressures. If so, there may be costs incurred in area-wide housing markets or perhaps within the community's infrastructure as the additional population demands more publicly supplied goods. Such results would be observed either through increased price, congestion, or a decline in quality.

From a national point of view, short-run MX-induced costs would be similar in principal to those observed above. Yet, they would be much more dispersed. Given scarcity, though, the nation's expenditure of $5 billion to $7 billion on full-scale development implies that society will be foregoing alternative goods and services. These foregone alternatives would be a national cost attributable to MX. In addition, since MX expenditures would be financed through taxes, wealth is redistributed from those persons who pay taxes, to those who derive benefits from MX spending. In general, tax burdens are dispersed nationally, while direct economic benefits would be experienced regionally.

6.2 SHORT-TERM GAINS

Just as with costs, expected gains primarily would be observed on a regional level. This is so since full-scale development expenditures are within particular regions within the nation. The following regional gains may result:

- Full-scale development expenditures within a regional economy over 4 years and 9-months will create additional job opportunities, and stimulate market demands for supplier goods and services.
- Given regional output increases resulting from MX investments, it would be expected that regional earnings, payments to capital and labor, would also increase.

On a national level, short-term benefits may include:

- Acquisition of potentially valuable technological innovations and background data for advancement of science and technology.

- Resolution of much uncertainty, including component performance capabilities, and systems costs. There may be an overall decline in national unemployment, as workers migrate to newly created jobs.

- For the nation as a whole, output may increase if resource inputs used for MX have been reallocated from less productive uses. This is particularly true for currently unemployed labor. Unemployed labor time is permanently lost. Application to MX-induced job opportunities would be a benefit since this labor time would not be lost.

6.3 LONG-TERM PRODUCTIVITY

Full-Scale Engineering Development does not result in concentrated environmental effects of the type that bring about long-term declines in the productivity of resources. The short-term social and economic gains—principally associated with employment provided for previously unemployed workers—are not at the expense of long-term productivity.

Resource Commitments

7
IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The major commitments are resources which must be utilized to provide for design, development, and testing phases of full-scale engineering development. Aggregate cost has been given as $5 billion to $7 billion, which measures the direct resource costs borne by society. Some resources, such as labor, cannot be retrieved once they are used. This is particularly true of workers' time. This would be a cost only to the degree that the work force is diverted from other uses. Employees drawn from the unemployed would constitute the beneficial use of a work force otherwise lost to society.

Inputs used for MX Stages I through IV, both propellants and casings, will be irretrievably committed. Materials for such components as guidance systems or armament could be retrieved if economically viable, although this is not anticipated. Similarly, capital inputs utilized for systems tests, design or assembly facilities, could potentially be retrieved.

All capital and labor directly used throughout full-scale engineering development is economically scarce, thus, society would forego alternative goods and services. Foregone alternatives also arise through indirect resource consumption. To the extent degradation of environmental quality, e.g., noise or pollution emissions, occurs in those regions developing and/or testing MX components, society bears a cost. Such degradation could be irreversible, but preliminary analysis indicates that its probability of occurrence is very low. As regional economies develop, there may also be alterations of land uses, such as conversion into urban uses. In general, these, too, would be irreversible, but the probability of such alterations due solely to MX is relatively low.

Offsetting Considerations

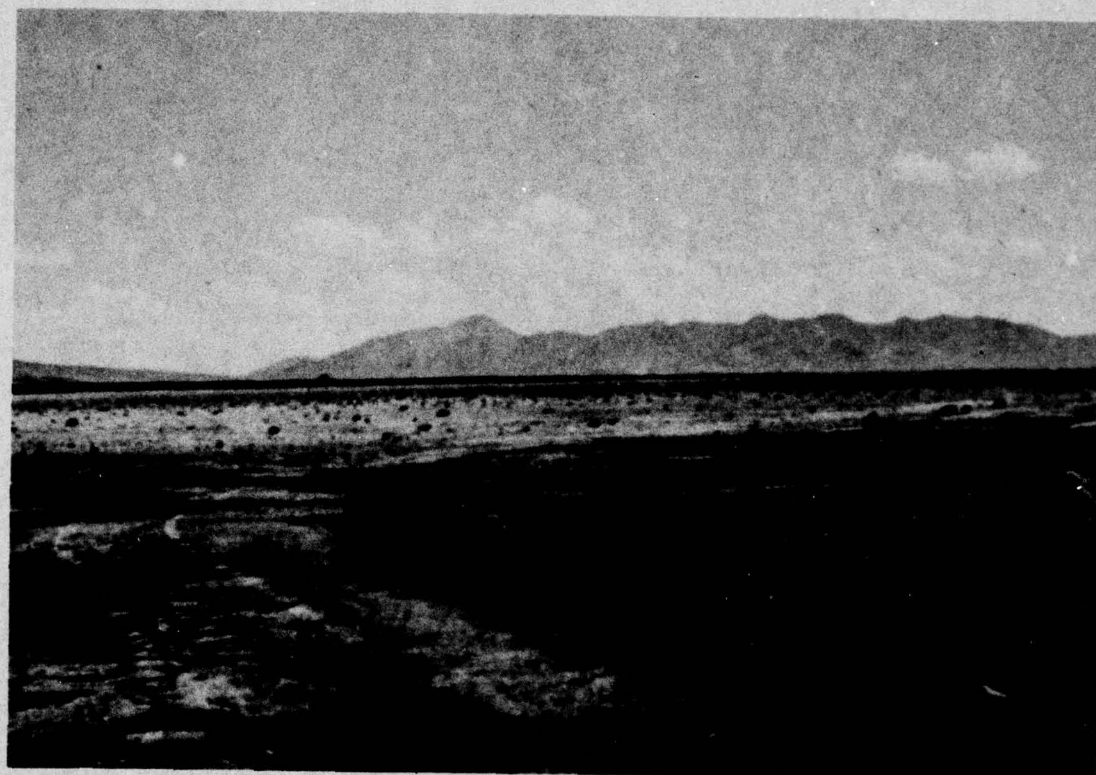
Offsetting Considerations

8
CONSIDERATIONS THAT OFFSET THE ADVERSE IMPACTS

The potential benefits of the MX full-scale engineering development are local, regional, and national in scope.

- At the local level, for those experiencing MX contractual awards, full-scale engineering development expenditures will create additional job opportunities and stimulate market demands for supplier goods and services. Further, the local tax base would increase, potentially lowering the tax burdens on local residents should community infrastructure elements be adequate.
- MX investments will also stimulate regional economies. First, this would be expected since workers directly employed on MX-affected industries would live throughout the region, not just in the particular area surrounding the MX contractor. Thus, their spending increases would be experienced regionwide. Second, as the directly affected industry expands, it is probable they would increase demands for goods and servies supplied within the region. This, too, would stimulate regional economies. Thus, the multiplied impact to the initial MX stimulus will be felt regionwide, though not as directly as local effects.
- National benefits of full-scale development at one level are part of overall MX benefits, since MX is achieved through design, development, and testing phases. Regarding the total MX program benefits, MX will help sustain the United States strategic deterent force as part of the response to the present upgrading of the Soviet Union's strategic nuclear forces. Without United States defense adjustments, the United States deterrent will diminish as Soviet missiles improve, particularly in number of warheads and accuracy. Since it is United States policy to not permit an imbalance to arise, MX will provide a defense system of increased range, throw-weight, and improved accuracy.

- Specific national benefits from full-scale engineering development arise as uncertainty of component design and performance capabilities is eliminated.
- Potentially valuable research and development will be performed, perhaps generating technological breakthroughs. This includes the development of resource data and analysis methodologies that will assist in the achievement of national environmental quality goals.



Unresolved Issues

9
DETAILS OF UNRESOLVED ISSUES

Since the MX system is still in a preliminary phase, there are several unresolved issues. Among the more important are:

- the timing of design, development, and testing of many components
- the aggregate, as well as specific costs, for missile components and associated facilities
- amounts and types of capital and labor necessary for full-scale engineering development
- selection of major contractors for the program

In many instances:

- Full-scale engineering development of MX will require advanced state-of-the-art production processes.
- New materials, new designs, and sophisticated support equipment will be utilized.

As full-scale engineering development proceeds, many of the above issues will be resolved. Appropriate environmental analyses will be performed to ensure compliance with federal legislation and to protect the environmental integrity of potentially impacted areas.

Addenda

ADDENDUM II-A

NATIONAL ECONOMIC IMPACTS OF MX FULL-SCALE ENGINEERING DEVELOPMENT

Summary and Conclusions

- The estimate of 130,000 jobs created, for an expenditure of $1 billion per year, for 5 years, in constant 1977 dollars, is based on a modified input-output approach.
- The estimates of national MX FSED impacts represent the likely outcome assuming high unemployment in the economy.
- Alternative estimates, using results from the Bureau of Economic Analysis quarterly econometric model, are developed and reported in this addendum. These estimates take account of alternative conditions prevailing in the economy during MX FSED and provide three different impact results, corresponding to three different assumptions about the level of unemployment in the economy into which FSED is introduced. These alternative estimates also take account of the opportunity cost by introducing the negative effect of increasing personal taxes to offset the cost of FSED.
- The alternative impact estimates range from 20,000 jobs, created under the assumption of low unemployment, to about 130,000 with high unemployment.

Impact Estimates

Chapter 3 provides a summary of the results of a national impact analysis relating to expenditures for MX Full-Scale Engineering Development (FSED). The approach used is that of Input-Output (I-O) analysis, modified to incorporate the Keynesian income effect. The National Input-Output model (Bureau of Economic Analysis, 1974) and a quarterly econometric model (Hirsh, June 1977), both produced by the Bureau of Economic Analysis, U.S. Department of Commerce, were used for this purpose.

The input-output model considers the interrelationships between industries by means of a set of linear equations.[1] Industry sales in the I-O framework are either sales to other industries (the sum of which is called intermediate output) or sales to final users who conduct no additional processing (called sales to final demand). The sum of intermediate output and final demand is called gross output.

In this framework, the sales of FSED to the Federal Government is a sale by the aerospace industry to final demand. In the process of producing the goods and services that make up FSED, the aerospace industry will purchase goods and services from other industries, these purchases representing the input requirements of the aerospace industry. The industries supplying these inputs, in turn, must purchase goods and services to produce them. The system of equations which makes up the I-O model, in this way, implies an infinite series of such input purchases branching out to include, conceptually, all industries in the economy. Input-output multipliers, which relate total gross output changes to final demand, permit the estimation of the total gross output associated with an industry-specific final demand change.

In producing its output, each industry uses labor and, as a result, earnings accrue to households. Earnings are defined as payments to labor in the form of wages, salaries and benefits, and proprietors' income. Households, in turn, spend a portion of these earnings for goods and services, which generates additional gross output and earnings. This earnings effect can be measured by the Keynesian income multiplier.[2] For this component of the impact, published results from the Bureau of Economic Analysis quarterly econometric model (Hirch, June 1977) are used. A detailed discussion of the derivation of the multiplier is found in Addendum II-B.

The I-O multiplier for the aerospace industry, estimated in the way outlined above, was found to equal 4.47. This means that a $1 billion change in sales of the aerospace industry to government results in a change of $4.47 billion of total gross output. Converting this gross output change to a change in earnings and employment gives the published results: increased earnings of about $1.5 billion, and increased employment of about 130,000 jobs. The results are obtained by multiplying the gross output change by a earnings-gross output ratio, and the resulting earnings by an employment-earnings ratio. Details of the estimation of these ratios are found in Addendum II-B.

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[1]For general discussion of the I-O model in analyses, see Miernyk, William H., *The Elements of Input-Output Analysis*, New York: Random House, 1967; or Cherney, Hollis B. and Clark, Paul G., *Inter-Industry Economics*, New York: John Wiley & Sons, 1959.

[2]The National Input-Output model does not include households as an endogonous sector, i.e., as an "industry" that interacts with other industries. To so include households would greatly exaggerate the total economic effects of a given change.

These estimates embody a number of assumptions about both the state of the economy into which FSED is introduced and the mechanism of the change that results. Fundamentally, the approach assumes that the FSED change, introduced at the margin (that is, representing an incremental addition to the economy), can be represented by average relationships in the economy. Thus, inputs required per dollar of FSED are identical to inputs required per dollar of pre-existing aerospace industry production. Similarly, additional earnings are associated with new jobs at the same rate as average earnings per job in the economy without FSED. Generally speaking, this assumption requires that there be substantial unemployed labor in the economy. Under this condition, the opportunity cost of applying labor and capital to FSED is quite small.

These assumptions result in impact estimates that are at the upper end of the range of all results that might be expected. There are, in fact, conditions under which these results would obtain, but the probability of these conditions prevailing throughout the period of FSED is small.

Alternative National Impact Estimates

Conceptual Framework:

The purpose of this section is to develop and discuss alternative national impact estimates. These estimates must reflect assumptions about the state of the economy into which MX FSED is introduced which are essentially different from those employed in Chapter 3. To do this, use will be made of the Bureau of Economic Analysis national quarterly econometric model (BEA Model) (Hirch, June 1977). This model was selected for use in this analysis for several reasons:

(1) The approach is essentially different from the modified I-O approach used in Chapter 3 and discussed above;

(2) Published results using the BEA model are based on simulations which have characteristics not unlike the FSED problem;

(3) Results are provided reflecting alternative assumptions regarding the position of the economy in the business cycle.

The BEA model is a complex quarterly econometric model of the national economy in which the behavior of the economy is summarized in a set of mathematical equations. It is composed of over 60 stochastic equations and is designed to handle a variety of analytical problems including the impact of changes in government activities such as taxes levied and goods and services purchased from the private sector. The characteristics of the set of equations reflect a number of features of the national economy, such as changes in price levels, the size of the labor force, inventory and capacity utilization, and consumption, as well as interactions among these effects. In order to analyze the impact of a change, the model is run twice: once

without the change—the control solution—and once with the change or disturbance introduced into the model. Results are obtained from each run for each quarter year. The impact of the change is estimated by taking the difference between the two solutions for a given quarter.

The model is best suited to the analysis of short-term phenomenon—not exceeding 20 quarters or five years. Beyond this point, the mechanism built into the model does not adequately characterize the process of long term change in the economy.

Application of the BEA Model:

Published results from the BEA model (Hirch, June 1977), provide Gross National Product (GNP) multipliers for each of five policy simulations. Of these, two are appropriate to the required FSED analysis. These are:

a. An increase of $5 billion in government purchases from the private sector, expended at the rate of $1 billion per year over a 5-year period. This will be used to represent the expenditure required for MX FSED.

b. An increase of $5 billion in personal taxes collected by the government, at the rate of $1 billion per year for 5 years. This will be used to represent an opportunity cost of MX FSED in terms of consumption and investment in the private sector which be foregone.

The net effect of MX on the national economy will be represented by the difference between these two effects.

In addition, published results are provided for each of three different cases reflecting the condition of the economy:

a. The high unemployment case, in which unemployment is controlled at the 8 percent level;

b. The low unemployment case, in which unemployment is controlled at the 4-1/2 percent level; and

c. The historical case, in which the 1971-75 historical period setting prevails, with unemployment rates ranging from 4-1/2 to 8 percent.

The "high unemployment" case represents a set of conditions in the economy which are similar to the assumptions underlying the impact results published in Chapter 3. The "low unemployment" case represents the other extreme with respect to available manpower and productive capacity. The most likely setting in which FSED will occur is that represented by the "historical" case.

Results are provided for a number of components of GNP and, (because the model has a price level variable that is sensitive to changes in demand, unemployment, and capacity utilization) total GNP is expressed in both constant dollars (real) and current dollar terms.

Employment impacts are derived from the model results in two ways. First, real GNP is converted to earnings, using the average ratio of earnings to GNP in the 1973-1975 period. Earnings are converted to employment using the 1973-1975 average ratio of employment to earnings (BEA, 1974a, 1977). This result is called Employment I. In the second approach, another result from the model—change in unemployment rate—is used in conjunction with the projected 1980 national labor force, to derive employment impacts. This is called Employment II.

These two results tend to provide upper and lower bounds on the actual impact. Employment I tends to overestimate the employment impact because it assumes that the marginal employment-output ratio is equal to the average ratio. This assumption is reflected in the use of factors to convert GNP to earnings and employment. Employment II tends to underestimate the actual employment change because when employment increases, particularly with a low unemployment rate, the size of the labor force tends to increase as well. Thus, some of the actual employment change is cancelled out by expansion of the labor force when the impact is based on changes in the unemployment rate. Of course, other factors are involved in the difference between Employment I and Employment II. Therefore, these characterizations are only average tendencies that do not hold in all situations.

Impact Results:

Results of the alternative impact analysis are presented in Table 1 and Table 2. These results represent the net effect of an increase in government expenditures and personal taxes. Table 1 provides detailed results for the historical case; Table 2 provides summary results for the low and high unemployment cases. For reasons indicated above, the employment impacts are probably within the bounds represented by Employment I and Employment II. These ranges vary from a 5 year average of 90,000 to 125,000 jobs in the high unemployment case, to 15,000 to 25,000 for the low unemployment case. The historical case has a range of from 25,000 to 50,000 jobs created.

These ranges, however, represent average levels over the 5-year period. One can see from Table 1, for example, that the year-to-year variation is substantial. In the early years employment change is relatively large by either measure. This is accounted for by relatively stable prices and the action of the induced investment effect. Both these positive influences, however, begin to subside by the third year and in the fourth year the net effect is practically zero. The induced

Table 1. Estimated MX FSED national impact[1] (billions of 1974 dollars) historical case[2].

IMPACT MEASURE	END OF YEAR 1	2	3	4	5	5-YEAR AVERAGE
Change in real GNP	+1.89	+1.62	+0.34	-0.25	-0.33	
Change in real earnings	+1.27	+1.09	+0.23	-0.16	-0.22	
Change in Employment I	+156,000	+132,000	+27,000	-20,000	-27,000	+54,000
Change in Employment II	+40,000	+50,000	+40,000	+10,000	-10,000	+26,000

[1]Assumes $1 billion/year expenditure for MX FSED coupled with $1 billion/year increase in personal taxes.

[2]Assumes conditions in economy corporate to the 1971-75 period, with the unemployment rate ranging from 4 1/2 to 8 percent.

investment which was stimulated initially has declined. The economy, by the fourth year, is approaching a new equilibrium level of output and price level increases beginning to overcome the real output change.

The same pattern over time can be seen on the other cases. The principal difference bewteen these two is the effect of the condition of the economy. In the low unemployment case, positive net effects would persist for only a short time; the high level of employment and capacity utilization in the economy result in the positive impacts of MX FSED being transformed into price level changes.

In summary, using this alternative approach to estimating the national impacts of MX FSED provides a range of results. This range varies from those which are of a magnitude similar to the estimates in the Chapter 3 (the high unemployment case) to those estimates which are considerably smaller (as in the low unemployment case). The issue which is critical to the outcome is seen to be the condition of the economy during the period of FSED expenditures. It is difficult, if not impossible, to forecast the state of the economy at the time of FSED. Thus, only a range of estimated impacts can be offered at this time.

Table 2. Estimated MX FSED impact[1] low and high unemployment cases[2] (billions of 1972 dollars).

IMPACT MEASURE	END OF YEAR					
	1	2	3	4	5	5-YEAR AVERAGE
Low Unemployment Case						
Change in Employment I	+123,000	+56,000	+16,000	-55,000	-67,000	+15,000
Change in Employment II	+50,000	+40,000	+30,000	+10,000	-20,000	+22,000
High Unemployment Case						
Change in Employment I	+163,000	+184,000	+188,000	+98,000	-3,000	+126,000
Change in Employment II	+80,000	+90,000	+110,000	+100,000	+60,000	+88,000

[1]Assumes $1 billion/year expenditure for MX FSED coupled with $1 billion/year increase in personal taxes.

[2]The low unemployment case assumes that unemployment without the project is maintained at 4 percent. The high unemployment case assumes an 8 percent rate.

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ADDENDUM II-B

DERIVATION OF NATIONAL IMPACT ESTIMATES

This addendum provides detailed derivation of the parameters used in the National Impact Analysis of Chapter 3.

Aerospace Industry Multiplier

A modified I-O approach was used. The direct and indirect components of the multiplier were taken from the BEA National I-O Model (Bea, 1974); the induced component was estimated using results of simulations with the BEA National Quarterly Economic Model (Hirsch, 1977).

Generally speaking, this approach assumes that there is considerable unemployment in the economy, and in the aerospace industry in particular. (Alternative impact estimates, under different assumption are provided in Addendum II-A.)

The open model I-O multiplier, which gives the direct and indirect changes, for the aerospace industry from the national I-O model is equal to 2.09 (BEA, 1974). The direct and indirect earnings associated with a change in this industry is:

$$(2.09) \quad (0.37) = 0.773$$

where 0.37 is the weighted earnings-gross output ratio associated with this industry and multiplier

$$\left(\frac{1}{2.09}\right) \quad (0.45)^{*} + \left(1 - \frac{1}{2.09}\right) \quad (0.301)^{**} = 0.37$$

* Aerospace industry earnings-to-gross output ratio (BEA, 1977)
** All-industry earnings-to-gross output ratio (BEA, 1977)

That is, a $1 change in final demand in the aerospace industry results in a $0.77 change in direct and indirect earnings.

Indirect earnings are given by the difference:

$$0.77 - 0.45 = 0.32$$

Induced earning change is estimated using a result from simulation of the BEA quarterly econometric model (Hirsch, 1977). Published results include an experiment involving an increase in transfer payments. The average annual result of the model for this case is an income multiplier of 1.63, under the assumption of high unemployment in the economy. This implies an induced income change of $0.63 associated with an initial income change of $1.00, in the form of a change in the transfer payment component of income.

Applying this result to our direct and indirect earnings change yields an induced earning dhange given by:

$$(0.77)^{*} \quad (0.63)^{**} = 0.485^{***}$$

* Direct and indirect earning per dollar of aerospace demand.
** Induced earnings per dollar of direct and indirect earnings.
*** Induced earnings per dollar of aerospace industry and demand change.

Associated with this induced earnings change is a gross output change equal to:

$$\frac{0.485^{*}}{0.301^{**}} = 1.61^{***}$$

* Induced earnings
** All industry earnings-to-gross output ratio
*** Induced component of gross output multiplier

Then the total multiplier is the sum of the components

2.09	(Open model gross output multiplier)
0.45	(Direct Earnings)
0.32	(Indirect earnings)
1.61	(Induced output component)
4.47	

Other Impact Parameters

1. Aerospace industry earnings-gross output ratio = 0.45 (BEA, 1977).

2. All industry earnings-gross output ratio - a weighted average of the aerospace ratio and the ratio for the entire economy, where components of the multiplier provide the weights:

$$\left(\frac{1}{4.47}\right)^{*} (0.45)^{**} + \left(1 - \frac{1}{4.47}\right)^{***} (0.301)^{****} = 0.34$$

* Initial effects component weight.
** Aerospace earnings-to-gross output ratio
*** Balance of change
**** Earnings-gross output ratio for total economy

3. Aerospace Employment Earnings Ratio

The industry is made up of five SIC-CODE industries, each contributed a proportion to the total and each with a different employment-earnings ratio.

COMPONENT SIC CODE	PROPORTION OF AEROSPACE IND.	EMPLOYMENT/EARNINGS EMP-5, WORKERS PER MILLION (1967) $ EARNINGS
357	0.057	108.6
365-7	0.158	112.7
372	0.667	119.8
376	0.096	118.9
382	0.022	132.8

Aerospace industry weights are based on the proportion that each component is of the total in the 1972 Census of Manufactures (Bureau of Census, 1972). Weighted average, using proportion of aerospace industry as weights, is 118.26.

Converting to 1977 dollars, using the consumer price index of 1.82 for 1977 expressed in 1967 dollars produced the required ratio:

$$\frac{118.26}{1.82} = 64.98$$ Workers per $1 million of earnings, in 1977 dollars

This implies per worker annual earnings of $15,400, in 1977 dollars.

4. U.S. Employment Earnings ratio (BEA, 1977a)

(1975 data in 1977 dollars)

$$\frac{92{,}500{,}400\ *}{1{,}071{,}300\ **} = 86.34$$

* Total employment
** Total earnings, millions of 1977 dollars.

This implies per worker annual earnings of $11,600, in 1977 dollars.

Impact Estimates: Summary Calculations:

Investment level = $1 Billion/Year

Δ Gross output = $4.47 x 1 = $4.47 Billion

Δ Earnings = $4.47 x 0.34 = $1.52 Billion

Δ Direct earnings = 1 x 0.45 - $0.45 Billion

Δ Indirect and induced earnings = 1.52 - 0.45 = $1.07 Billion

Δ Total Jobs = $1,520 million x 86.34 = 131,000

Δ Direct Jobs = $450 million x 64.98 = 29,000

Δ Indirect Jobs = 131,000 - 29,000 = 102,000

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